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The Kingdom of the Tides

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THE Kingdom of the Tides is a long and narrow kingdom. It extends for thousands of miles along our coasts. Its width spans the distance between the high and low-tide marks and as far beyond the latter as the influence of tidal currents may be felt. The subjects of this kingdom, the sea animals and plants ruled over by that most arbitrary of tyrants, the tide, are numbered by millions. Their species and varieties mount into the thousands.

The tidal zone, that fluctuating boundary between land and sea, probably witnessed the birth of the first living forms, and certainly was the primal battleground of the struggle for existence which led to the evolution of all the great animal and plant phyla. Here on the continental shelf, as nowhere else in the sea, are to be found the combination of sunlight, air, warmth, intermingling of currents, shallow sea-bottom of rock, sand or mud, and the neighborhood of streams bearing their eroded burdens of terrestrial chemicals necessary for the protoplasmic formula. However life originated, here it multiplied, spread and varied through all its potential mutations. Here the struggle for existence sifted out misfits, while the differing character of the water-covered substratum made it possible for creatures, varying in the appropriate directions, to assume swimming, creeping, burrowing or stationary habits of life.

Seashore animals and plants as a whole are tied up to their particular kind of environment to an unusual degree, often forming interlocking associations of species, sometimes unrelated, but having the same life requirements. This is best understood by considering a few of the most characteristic types of environment and the associations of living forms found in them.

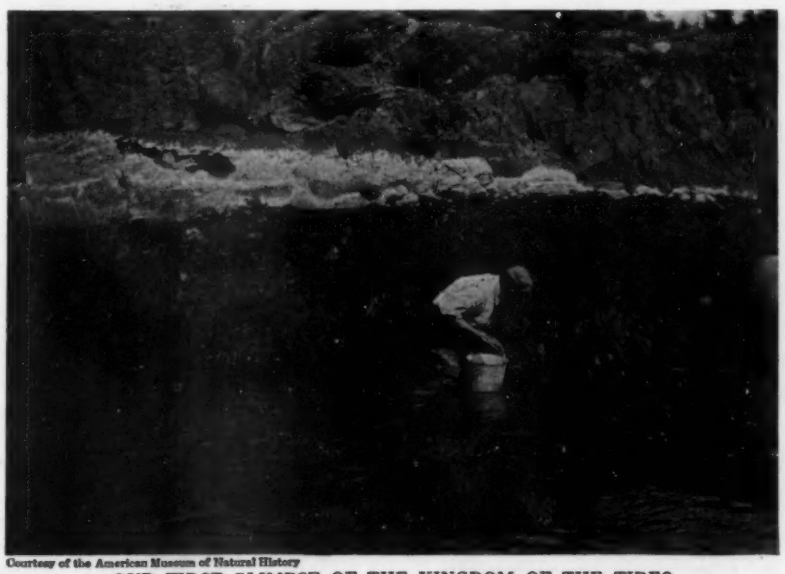
An Efficient Street Cleaning Department

First, let us visit a sheltered corner of the harbor of Woods Hole, Massachusetts. We have rowed out to the inner side of a little island located at the harbor entrance. Here the encircling tides, losing their force, have gradually deposited their load of soil eroded from the borders of the tide rip. In the muddy bottom thus formed, patches of eel grass have sprung up, their tips just projecting above water at low tide. Pushing a water glass before us we wade waist deep to the edge of one of these submerged forests. Peering through the glass we gain our first glimpse of the Kingdom of the Tides. As we approach, scallops lurking among the weedy clumps, leap upward from the sea bottom, propelling themselves by opening and closing their shells, thus forcibly ejecting the water. They dart here and there in irregular grasshopper-like flight, finally settling down among the weeds at a more distant spot. Here a scallop has come to rest in a little clearing, and opening its shell valves slightly, discloses a double row of steel-blue eyes just inside the shell margins. When examined with a hand-lens in the laboratory, these eyes are seen to possess well developed lens and cornea and other features which suggest the eyes of higher animals.

The sandy mud at the edge of the eel grass is a busy place. Hosts of hermit crabs run hither and thither gathering in groups about bits of decaying plants or a dead fish, where they are soon joined by slowly moving mud snails which glide steadily over the bottom, leaving a groove-like trail in the mud as they advance. They and the hermits are the street cleaning department of the shallow waters. Every particle of detritus is quickly detected and consumed by them.

The hermit crab is one of the most remarkable instances of adaptation among animals. The free-swimming young has symmetrical limbs and abdomen, and the latter is covered with horny plates. As development proceeds, the abdomen becomes bent to the right, the abdominal limbs on that side are lost, and the protective horny plates entirely disappear. Thus the animal, as it approaches the adult stage, is handicapped with a soft tapering abdomen with a spiral twist to the right.

To protect this vulnerable part of the anatomy from his enemies, the hermit crab has acquired the habit of appropriating the empty shell of some sea



Courtesy of the American Museum of Natural History

OUR FIRST GLIMPSE OF THE KINGDOM OF THE TIDES

At low tide the animals and plants of the tidal zone are exposed in a long ribbon-like frieze. The white band is composed of millions of rock barnacles, below which festoons of seaweed completely cover the rocks

Courtesy of the American Museum of Natural History

NATURAL BRIDGE AND ROCK TIDE POOL AT NAHANT, MASSACHUSETTS

At the foot of a sixty-foot cliff a natural bridge is uncovered at low tide overarching a tide pool twenty feet in length. The pool displays a remarkable assemblage of animal and plant life. The high-tide mark is shown by the upper limit of the barnacle zone

snail into which it inserts its soft hinder portion. As the crab completes its growth, the abdomen shapes itself exactly to the spiral cavity of the shell; the last appendage on the left side becomes hook-shaped and seizes firmly on the columella within, and the adult crab proceeds on its way protected by a portable castle. When assailed, he retreats within this, blocking the doorway with one of his large pincer-like claws which has grown to fit the shell opening exactly.

The story does not end here, for when the crab prospers by much feeding and waxes too large for his apartment, he calmly searches out another shell, eats out the snail, if present, and by a series of alternate trials decides whether the new habitation fits better than the old. If it does not, he resumes his first house and marches off to make another try.

Nymphs and Godesses of the Sea

Other sea creatures which may be considered members of the eel-grass association are the edible blue crab, the green crab and the spider crab. To the eel grass itself adhere many small forms such as the *Grantia* sponge, ascidians, hydroids and encrustations of bryozoa. All that we have mentioned, however, are beings that creep, swim or cling. There is another most characteristic class that must not be omitted, namely, the burrowers.

If we look about in the open spaces between the patches of eel grass, especially where the mud is somewhat sandy, we can see projecting up through the sea bottom the chimneys of homes belonging to dwellers in the subways beneath the sea. There are many sorts of these. We shall mention only a few. Here and there we see what at first sight appear to be clumps of shell fragments and bits of seaweed, drifted together by the tide. On closer examination these are found to be neatly cemented about a central opening, forming a camouflaged chimney. As we watch, a little cluster of delicate tapering "feelers" extends speculatively from the opening, waves about for a moment, and is quickly withdrawn.

Let us now dig with our hands down into the mud around the chimney. We find it leads into a long, flexible tube, with parchment-textured wall, which extends about eighteen inches down into the mud, tapering gradually to a slender tip. It is so delicate toward the lower end that it is almost impossible to remove the tube without breaking it. We take it to the laboratory and slit it open in a dish of sea water, thus freeing the inhabitant and architect of this sea bottom home. A long slender body, clad in jointed armor of brilliant, iridescent blue, glides into view, its shoulders adorned with waving scarlet plumes, and bearing five lance-like tentacles upon its head—a veritable knight of the sea. Its beauty and grace are so striking that we hesitate to classify it among the humble worms, as indeed we must, for we recognize it as *Diopatra*, the plumed worm.

The sea worms are the aristocrats of the group, and among them there are so many beautiful and graceful forms that the naturalists who discovered them gave them names of sea nymphs and goddesses, such as *Amphitrite*, *Nereis*, *Eurythoe* and *Aphrodite*.

Courtesy of the American Museum of Natural History

CORNER OF THE NAHANT TIDE POOL

A colony of expanded and contracted sea anemones. The ledge on which they are situated is fringed with delicate flower-like hydroids. A detail of a tide pool group modeled from life

Why is it that so many diverse forms are associated on this muddy bottom in the neighborhood of the eel grass? The answer is contained in the mud itself, and in the similar physiological needs of the organisms concerned. The mud is rich in the nitrogenous compounds required by several of the animal and plant species found here, and itself forms a refuge for the burrowing forms.

Other animals in the community, like the whelk and the crabs, prey on the mud dwellers, while the tidal currents bring in fresh quantities of mud, disseminate particles of detritus, and afford a continuous supply of micro-organisms. Thus, the tide is the ultimate provider and arranges an environment in which the creatures suited to it find their home and sustenance.

Leaving the low-lying sandy and muddy shores of Southern New England, we sail around the outstretched, bent arm of Cape Cod and enter the Gulf of Maine.

From a region of sand and mud flats and relatively low tides, we have been transported to a rock-bound coast of steep cliffs and progressively high tides. The rocky headlands begin north of Boston at Nahant and Cape Ann. Here the tide rises nine feet vertically, as compared with five feet at Woods Hole.

This means a radical change in the environment in our Kingdom of the Tides, naturally reflected in the personnel of the sea creatures inhabiting it. The substratum is rock. Therefore, the burrowers are absent except where beaches and mud flats form in sheltered coves. Because of the force of inrushing tides, the creepers and swimmers must take refuge in crevices and rock-pools or be washed out to sea. Animals with clinging organs, however, are particularly adapted for these conditions and are conspicuous by their abundance.

Barnacles the Acrobats of the Sea

The tidal zone is situated vertically on the face of the cliffs, and its intertidal portions are displayed at low tide, stretching like a banded ribbon along the rocky wall. The upper limit of this band is the high-tide mark. Here a long, snow-white frieze is conspicuous even at a distance. Close at hand it is seen to be composed entirely of millions of the closely crowded limy shells of the rock barnacle. This creature when first hatched resembles a shrimp and swims about freely through the water. Later it settles down on the rocks and builds about itself a tent-shaped shell of calcareous plates, with folding doors of limestone closing the opening at the top. Within this chamber the adult barnacle lies on its back with its many-branched delicate feet curled above its head.

When the tide rises so that the sea covers the barnacle zone, the shell doors open, the feathery feet uncurl and extend out into the sea, withdrawing within the shell at frequent intervals in a series of quick jerks, entangling as they do so myriads of diatoms and other microscopic organisms brought in by the beneficent tide. Agassiz has said that the barnacle is merely a shrimp standing on its head and shoulders within a shell and kicking its food into its mouth with its feet. When the tides recede, the barnacle is left high and apparently dry on the rocks at the upper tide limit. It can stand exposure

Courtesy of the American Museum of Natural History

CAPTURING AN UNWARY LADY CRAB

A lobster lurking in a rock crevice near a sandy bottom springs out upon a lady crab which has emerged from its hiding place in the sand. The crab frantically endeavors to escape by swimming up into the water with its paddle-shaped hind legs

Detail of a group in the American Museum of Natural History

AT THE EDGE OF THE EEL GRASS

Mud minnows have disturbed the scallops lurking among the weedy clumps and one is seen swimming. A channeled whelk is stalking them for food, while hermit crabs, mud snails, and the "chimneys" of burrowing worms are visible on the sea bottom

to the air longer than most sea-animals, for it encloses within its shell a quantity of sea water which bathes its soft body until the next tide.

The common periwinkle snail shares with the barnacle the honor of living highest among the rocks, for it has the similar habit of imprisoning sea water within its gill chamber, and in fact is in a transitional stage toward becoming an air-breathing land mollusk.

The zone of barnacles and periwinkles is overlapped below by the rockweed and mussel zone. Here the barnacles are replaced by the close-set shells of the edible mussel extending down the rocks and below the low-tide limit. The colonies are covered with thick growths of olive-green and yellow-brown rockweed.

Snails the Source of Tyrian Purple

If we lift the rockweed from an exposed rock, in sheltered crevices, we may find grouped together numerous brightly colored and banded "purple snails," so-called, not because they are necessarily purple in color, but because they exude a brownish fluid which, upon exposure to the air, becomes a brilliant purple. This was the ancient Tyrian purple dye, the royal purple of the Roman emperors, extracted by the Phœnicians and later by the Romans from mollusks of this and related families. Near the snails we may find clusters of their goblet-shaped, delicately tinted egg cases, often containing embryo snails. The purple snail feeds upon the mussels and barnacles as well.

Below the rockweed zone we find successively overlapping zones characterized by typical seaweeds and animal associations, which can stand at most a short exposure to the air or must be washed by the sea continually. Here grows the red dulse, the edible seaweed which finds its way to our markets, and also

Courtesy of the American Museum of Natural History

CRABS SPARRING IN A SEA GARDEN

A blue star fish is stretched out on the pool bottom. Nearby is a group of green sea urchins. Detail from the tide pool group in the American Museum

the brown and violet-tinted Irish moss, an important source of commercial gelatine. Associated with them are many-colored sea stars and hosts of green sea-urchins, the latter small in size but rejoicing in the record scientific name, *Strongylocentrotus dræbachiensis!* Here too are crowds of sea anemones, and floating gardens of brown kelp of two sorts, the long, ruffled devil's apron string and the fan-shaped divided fronds of the fingered kelp. Still below these, the rocks may rise from a sandy bottom, where the lobster lies in wait to spring out upon unwary sand-burrowing crabs, and that living fossil, the horseshoe crab, lumbers along hunting for creeping animals as he has done for untold geologic ages.

These are a few of the multitudious organisms occupying the bandlike zones of the northern seas. Their stratified associations are due to the ability of some to withstand exposure to the air near the upper tide limit, while below, their colonies are bounded by the animals that feed upon them, but which themselves can stand little or no exposure.

The seaweeds, too, are arranged with relation to both the exposure factor and their need for sunlight, the upper zones being composed of algæ that need more light than those farther below the surface of the sea.

This orderly banded arrangement, however, is considerably modified here and there by the basins in the rocks known as tide pools. These are located between the tide limits in the midst of the associations of animal and plant species forming the upper zones. At low tide they remain filled with sea water and, therefore, also support species characteristic of the lowest totally submerged zones. The eggs and

Courtesy of the American Museum of Natural History

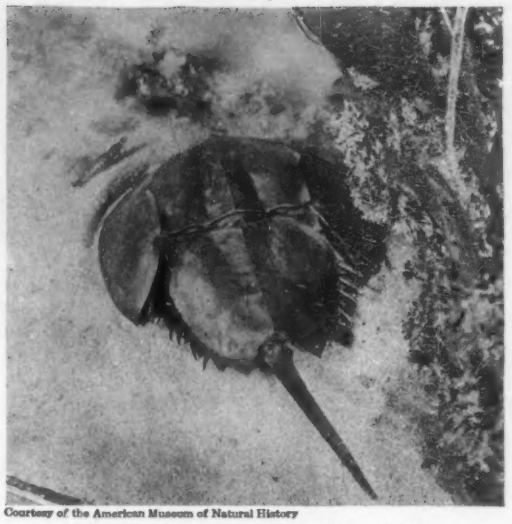
THIS SNAIL SECRETES A ROYAL PURPLE DYE

The "purple sea snail" congregates in clusters beneath the rockweed along our rocky coasts. It varies greatly in sculpture and color, some being brilliantly banded in orange or brown and white. A cluster of egg capsules is shown nearby

young of these species are brought in with every recurrent tide and soon obtain a foothold within the pools. So these rock basins become veritable gardens of the sea, supporting a concentration of living creatures of almost unbelievable variety of form, color and habit of life.

At Nahant, Massachusetts, at the foot of a sixty-foot cliff, there is a remarkable tide pool, overarched by a natural bridge exposed at low tide. The summit of the arch is white with barnacles, while its sides are adorned with mussels and draped with rockweed. The pool itself extends completely through the arch for a distance of twenty feet. As a beam of sunlight strikes athwart the pool, it lights up a rounded boulder covered with gray-green chimney sponges overgrown with Irish moss, the violet iridescent tips of which gleam like jewels.

The edge of the rock is fringed with rich green ruffles of sea lettuce which float out from its side above a gravel-strewn gully, gay with sea stars of purple, red, blue and orange. One side of this gully is thickly hung with green chimney sponges and pink finger sponges, framing in rose-colored masses of jelly-like ascidians. The other side, variegated with calcareous algæ and encrusting sponges which



Courtesy of the American Museum of Natural History

THE HORSESHOE OR KING CRAB

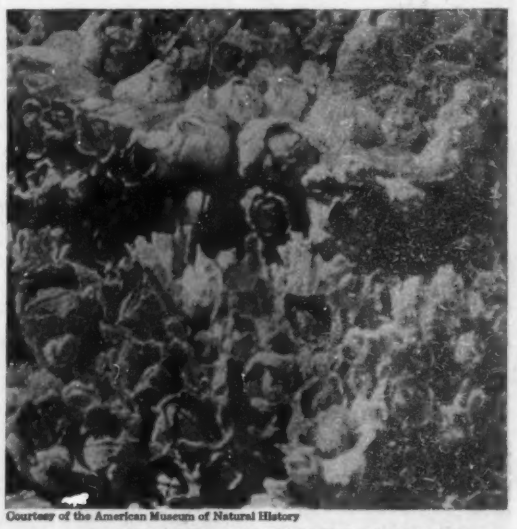
This strange creature inhabits the sea bottom along the entire New England coast. Specimens are often found in the tide pools. It is practically a "living fossil" having survived with little change from early geologic times

completely cover the rock, mottling it with dark red, rose pink and green, is also overgrown with feathery pink corallines.

Beyond this ledge a second crevice forms a lurking place for the red Jonah crabs, while green crabs fence with each other under the ruffled streamers of brown kelp. Sea anemones expand their soft, brown and orange cylinders crowned with fluffy circlets of tentacles on an overhanging shelf, the edge of which is adorned with bunches of fairy-like pink-hearted hydroids.

King Tide the Beneficient Provider

All this riot of life and color exists crowded within a single pool, and we wonder how so many living forms can find sustenance within so small a space. The answer comes even while we gaze. A stream of water from the returning tide overflows the seaweed draped rocks and oozes into the pool. Then a second, followed by a dash of spray from a catapulting wave, inundates the shelf where we stand. Now the "white horses" rush in upon the outlying ledges, creating a swell which overwhelms the pool, and as we watch the swirling dash of the oncoming tide, we realize that its waters, swarming with microscopic organisms and aerated by constant violent motion, are the means by which King Tide twice a day supplies the needs of his subjects of the tidal zone.



Courtesy of the American Museum of Natural History

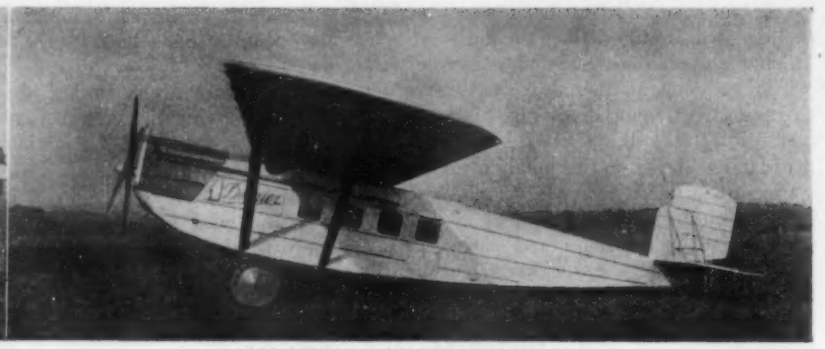
A CROWDED BARNACLE COLONY

The shape of this barnacle varies greatly. In crowded parts of the colony the individuals are high crowned and slender. In less crowded places they are low and flat

J. H. W. Kerston

BRISTOL PULLMAN BIPLANE

This plane is driven by a 400-horsepower Bristol Jupiter engine. It is a ten-seater and is the only large passenger plane fitted with an air-cooled engine



ALL-METAL DORNIER KOMET III

In the London-Berlin service. It has a Rolls-Royce 360-horsepower engine. Carries six to nine passengers. Its span is 64 feet, length 40 feet and speed 120 miles an hour

Air Traffic in Europe

How the Old World Is Developing a Neglected American Invention

THE practical use of the airplane as a means of transportation is making remarkable headway in Europe; whereas, in America, but one commercial route has been established up to the present. Little commercial use has been found for airplanes, if we except the great service they are rendering in delivering mail to distant points, as shown by the fact that New York mail reaches the west coast in about thirty-six hours, while the ordinary mail service requires an average of from four to five days.

The map given with this article shows the most important regular air routes in Europe during the summer of 1924.

Planes Used for Great Distances

As can be seen from this map, the airplanes are mostly employed for trips to far distant points. As the most important line from west to east the route via Geneva-Zurich-Munich-Vienna-Bucharest-Constantinople-Ancora must be mentioned. Another important route goes from Munich via Berlin to Helsingfors in Finland.

On account of the great distances in Russia, the practical use of airplanes has more importance to the Soviet republic than to any other country in Europe. The most important route in Russia goes from Leningrad, the former St. Petersburg or Petrograd, via Moscow to Baku on the Caspian sea, with an extended line to Teheran in Persia. The importance of such air routes for Russia is best shown by pointing out, that the fastest express train from Moscow to Tiflis requires almost four days of uninterrupted traveling, while the airplane can negotiate the same distance in twenty-three flight-hours. It could almost be said, that it is only by the extensive use of the airplane that the huge Russian republic, for many years to come, can be effectively controlled from one center.

Are We a Negligent People?

Consider the neglect of commercial aviation in this country, and then ask what in the world has become of American enterprise. We invented the airplane, neglected it, and left to Europe the task of putting it into widely extended commercial service. As a people we are supposed to have a perfect genius for practising rapid-fire methods in our industrial activities. We are supposed to have developed time-saving into an exact science and have shown the world how to practise it.

In the airplane, the Wrights gave us a time-saving machine which, if our business men had not been so possessed with the desire to make money and make it quickly, would today be one of our principal means of transportation for men, mail and light freight. Save for the fine work of the Army, the Navy, the Air Postal Service and a few private firms, we have done practically nothing, leaving to Europe the developing of commercial transportation.

Cost of Air Transportation Not Great

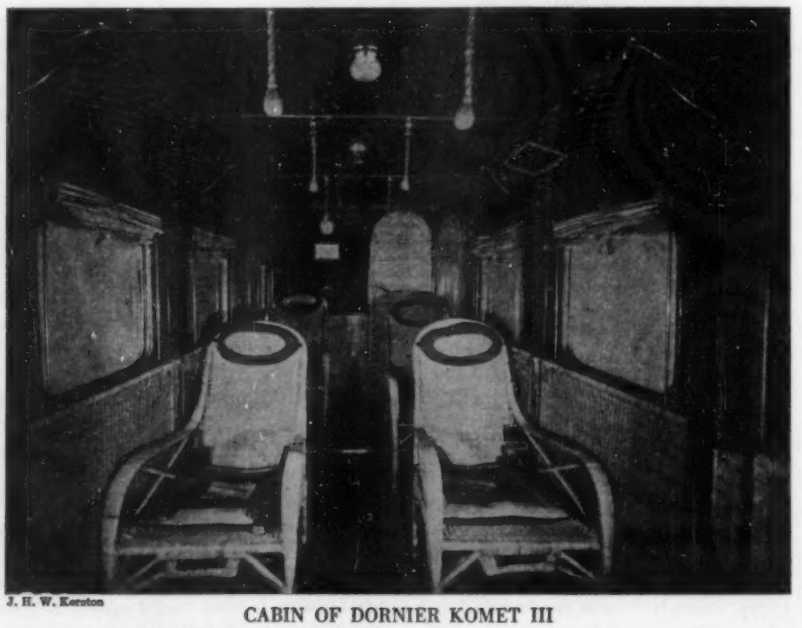
The airplanes have the same outstanding importance for the traffic of Central Europe. A few figures will easily demonstrate it. The trip from Zurich, Switzerland to Budapest, Hungary, today requires eight hours, including two stops of thirty minutes each at Munich, Bavaria, and Vienna, Austria, while the fastest express train would require twenty-three hours more. The cost of such a trip is only slightly higher than that of traveling by express train, the difference in price of the ticket from Zurich to Vienna being 1,760,000 Austrian crowns, or about $24. On the other hand the saving amounts to one whole working day.

If it be true that "Time is Money" the use of airplanes certainly represents a saving which should

J. H. W. Kerston

CABIN OF BRISTOL PULLMAN TRIPLANE

This plane has accommodations for sixteen passengers and their baggage. It is divided into front and rear cabins



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CABIN OF DORNIER KOMET III

The cabin of this plane holds six wicker chairs and has three reserve seats. Door in the rear leads to washroom

appeal with great force to the modern business world. The trip from Paris, France, to Constantinople, Turkey, via Prague and Vienna requires exactly twenty-five flight hours, not considering the stops, while if the traveler makes the same journey by train, he spends three boresome and wasted days in his seat.

The German engineers have spent a great amount of energy in order to adapt their airplanes to practical use, and a large proportion of regular air routes, especially in Russia, is carried on by German machines. The most popular German make is the Junker metal airplane.

Unfortunately there are no official international statistics of the air traffic, and the only figures available are those of the Junker factories, which we shall use in order to demonstrate the enormous development of air traffic in Europe during the past three years.

The traffic in Junker metal airplanes shows the following figures:

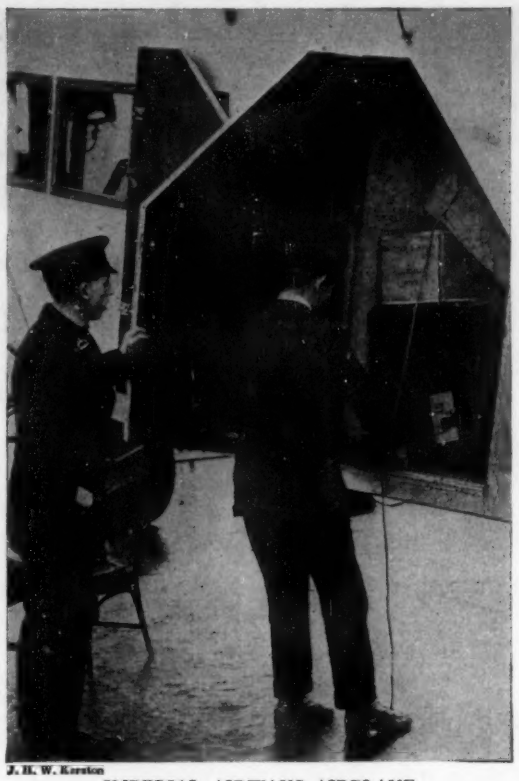
	1921	1923
Passengers carried	2,230	26,509
Mail and freight carried in pounds	5,500	147,407

This imposing traffic of the last few years, consisting of about 40,000 passengers and over eighty-five carloads of merchandise, was executed without a single accident and almost all flights reached their appointed destinations.

Customs Regulations Are Simplified

Today the air traffic is an important factor in European life, and when the figures for the current year are published, they will again show a large increase in the number of passengers and amount of merchandise carried.

It would seem that the carrying of passengers is the more important item in air traffic, but this is not so. The above figures and the statistics of other countries prove that the delivery of freight through the air will be the backbone for the development of air traffic, as it is now the main revenue of railroads. With three and a half times more distances covered, the passenger traffic has increased ten times and the freight traffic thirty times.



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IMPERIAL AIRWAYS AIRPLANE

Loading the baggage compartment. Note the large steamer trunk

It is not only the postal service in Europe that makes increasing use of the air routes. Industrial and commercial interests are awaking to a realization of the value of the high speed and ever increasing reliability of commercial air service. The present freight shipments through the air include medicine, watches, jewelery, milliner's supplies, films, small novelties, laces, perfumery, flowers, books, stationery, and so on. It also is of great importance to the trade, that the custom house formalities are simplified, especially when the shipment has to cross the border lines of various states. Russia and other countries make considerable use of the airplane traffic for the shipment of expensive furs.

The German-Columbian Air Traffic Corporation "Scadta" reported a case, where a bank crisis in Columbia was avoided through the delivery of sixteen cases of banknotes and securities within twenty-four hours. This particular shipment weighed 3,000 pounds.

Revolutionizes Postal Service

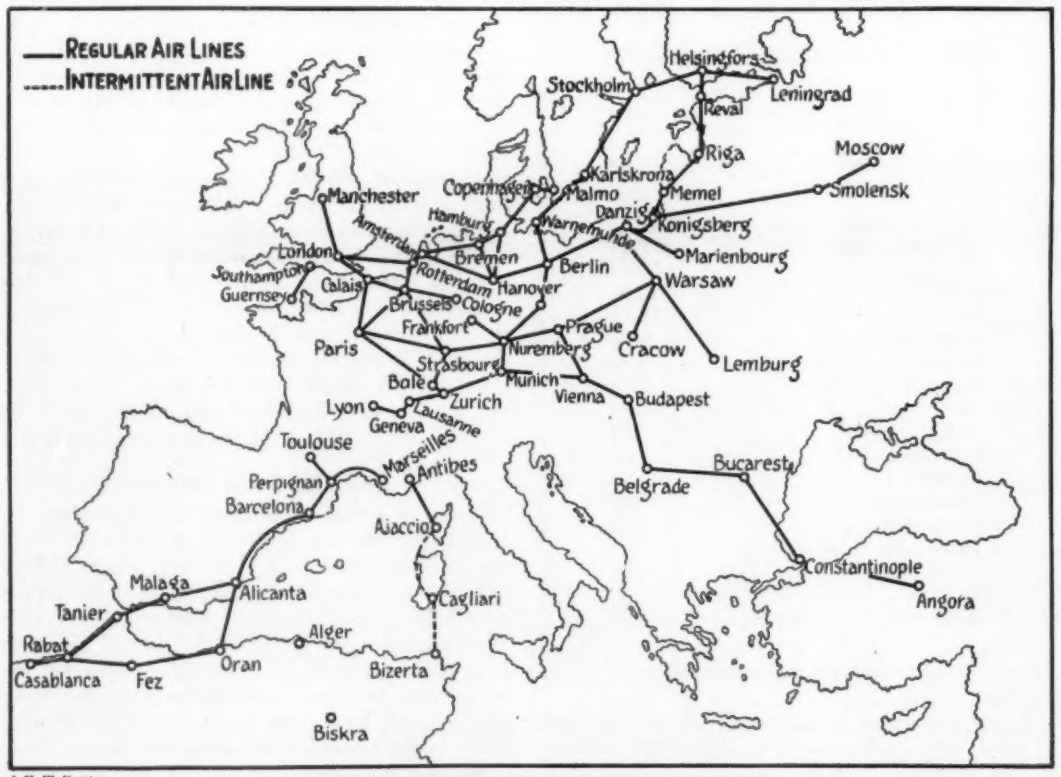
The fact that letters from Vienna to Prague or Budapest are delivered within two hours shows that the postal service is on the eve of a complete revolution. It is reported that the next year will see an air route from Vienna to Berlin in five hours, and from Vienna to London in ten hours. These three capitals will then be able to read the same newspapers on the same day.

The airplanes used most extensively for the European air routes have a length of about thirty-five feet, a height of about eleven feet, and a width from wing to wing of sixty feet. The weight is 3,850 pounds and the carrying capacity 1,350 pounds. The machines are built in their entirety of duralumin. The comfortable cabin offered to passengers does not need to fear comparison with our Pullman car.

Without undue optimism, it may surely be claimed in the light of the above facts, that the future of freight and passenger traffic in Europe is assured. As to the fate of the Zeppelin, although the promise is not so great, the past performance of the lighter-than-air type is such as to assure its future—*provided the formidable problems of landing and housing can be solved.*

So far as comfort, safety, speed and large radius of action are concerned, the Zeppelin has established itself. In Europe it has carried many thousands of passengers in regular service without an accident. The long-distance performances of our own Shenandoah and Los Angeles speak for themselves.

That the British have faith in the lighter-than-air type is proved by their building two of 5,000,000 cubic feet capacity for service to India.



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THE HIGHLY DEVELOPED AIRWAYS OF EUROPE

This is no "pipe dream." Finely appointed planes are running day by day with regularity and dispatch on the routes shown here

Some Routes in European Air Service

London-Paris

London	12:00 Noon	Paris	12:00 Noon
Paris	2:30 P.M.	London	2:30 P.M.

Paris-Basle-Zurich

Paris	9:00 A.M.	Zurich	8:00 A.M.
Basle	12:15 A.M.	Basle	9:15 A.M.
Zurich	1:00 P.M.	Paris	12:00 Noon

Single Fares

London-Paris	$32.00
London-Basle	50.00
London-Zurich	55.00

London-Brussels-Cologne

London	9:30 A.M.		
Cologne	1:00 P.M.	Fare (single)	$28.00

London-Amsterdam-Berlin

London	8:00 A.M.	9:00 A.M.	10:00 A.M.
Rotterdam	10:35 A.M.		12:45 P.M.
Amsterdam ...		12:05 A.M.	1:30 P.M.
Hanover	2:00 A.M.		
Berlin	3:50 A.M.		

Single Fares

London-Rotterdam or Amsterdam.....	$20.00
London-Hanover	35.00
London-Berlin	40.00

AIRPLANE PASSENGER TIMETABLE

These times and fares tell the story of European commercial aviation

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The author, Dr. Henry S. Washington, in his laboratory at Washington, D. C., where he has made hundreds of careful analyses of the rocks of the earth's crust from all parts of the world

What the Earth Is Made Of

By Henry S. Washington, Ph.D.
Geophysical Laboratory, Washington, D. C.

THERE are two common misconceptions regarding the earth. One is that Columbus was the first to conceive of the earth as a sphere. Actually the ancient Greeks, hundreds of years before Christ, knew the earth to be globular. They even measured it, with results not very far from the truth, as they calculated the diameter to be about 7,500 miles, instead of 8,000 miles, the approximate real value.

The second misconception is that the earth is made up of a huge ball of liquid fire or molten rock, surrounded by a thin shell or crust of solid rock. But geologists now believe the earth to be solid and rigid throughout, from the surface to the center. They also believe that the interior is probably not tremendously hot. I am going to try to explain why we think this, what we believe the earth to be made of, and how we believe it to be constituted.

The Crust Would Crack

The chief reason why we believe that the earth is solid and not a thin crust, floating, so to speak, on a mass of very hot liquid, is that an earth made up like this of a thin crust and a liquid core could not withstand the tremendous tidal pulls of the sun and the moon. The attraction of the moon causes the tides, by which the waters of the ocean are raised a few feet twice a day. A much smaller tide, which has been measured only recently, is in the same way caused in the solid crust of the earth. The strength of the different kinds of rock is well known and it is calculated that a crust of any rock, even if it were hundreds of miles thick, would be broken up by these lunar tides and by the tides and twists of the earth caused by the sun. Indeed, even if the crust of the earth were many times stronger than steel it could not hold together under these strains.

Another reason why we believe the earth to be solid is that if it were liquid inside it would not spin around its axis so evenly or in the same way as it does now. This can easily be tested by trying to spin a raw egg on one of its ends. It simply won't spin but will fall over on its side. But if the same egg is boiled hard it can be spun easily.

Chemical Element of the Earth

The following chemical elements are now believed to constitute almost the entire mass of the earth. The remaining elements, including most of the useful metals, are present only in very minute proportions

	Per Cent
Iron (as metal)	31.82
Iron (as compounds)	7.94
Total Iron	39.74
Oxygen	27.71
Silicon	14.53
Magnesium	8.69
Nickel	3.16
Calcium	2.52
Aluminum	1.79
Sulphur	.64
Sodium	.39
Cobalt	.23
Chromium	.20
Potassium	.14
Phosphorus	.11
Manganese	.07
Carbon	.04
Titanium	.02

Earthquakes give us another proof that the earth is solid. An earthquake is caused by the slipping of the rocks, not more than about five or ten miles under the surface along the sides of a crack or fault, as it is called in geology. This slipping starts vibrations or waves, not only along the surface of the earth, like the waves in a pond of water when a stone is thrown into it, but also through the interior of the earth. These internal waves are of two kinds; one in which the vibrations are parallel to the line of travel and the other in which the vibrations are transverse to or across the line of travel.

Now it is known by experiment as well as by calculation that such transverse waves cannot pass through a liquid. But these waves are actually detected on seismographs at places as far away as one-third or more of the distance around the earth from the place of an earthquake, so that they must have traveled very deep down and pretty close to the center of the earth. We know, therefore, that the earth is solid down to such depths at least.

The earth is hot inside, as evidenced by volcanoes and hot springs, and by the fact that in all deep mines and bore holes there is a steady increase in the temperature with increase in the depth. But the earth is not necessarily hot enough to melt its interior. We know that the lavas of volcanoes originate at very shallow depths, about five or ten miles down. Hot springs are even shallower.

How Hot Is the Interior?

The increase in temperature in deep mines and bore holes differs considerably at different places, but, on an average, it is about one degree, Fahrenheit, for each sixty feet of depth. But the deepest bore holes are only about a mile and a half deep. They are mere pin pricks in the skin of the earth. It is obviously rash to assume that the same rate of increase in temperature shown over this small distance will hold good for the whole 4,000 miles down to the center of the earth.

We know, in fact, that part of this increase, if not most of it, is due to the presence of radium and of other so-called radioactive substances. There

is good reason to believe that these substances are most abundant in the uppermost forty or fifty miles of the earth and that they are not present at great depths. From these and other considerations we now think that the temperature does not increase so steadily downward and that the interior of the earth, while quite hot, is not so tremendously hot as it was once thought to be.

It is hot enough, perhaps, to melt all the metals and all the known rocks, if they were at the surface, but two important additional facts have to be considered. One is that the pressure is increasing steadily downward and becomes enormous only a few miles below the surface. The other is that rocks, like almost all other substances, water being an exception, expand on heating and, especially, expand very much on melting. For this reason a rock does not melt if the pressure is sufficiently great.

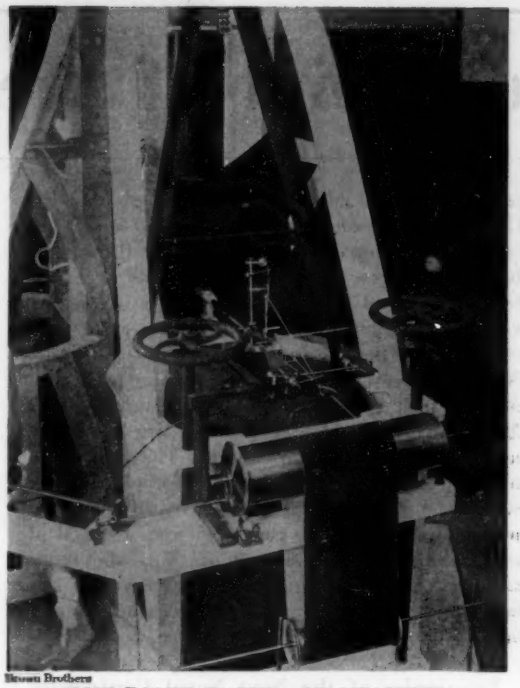
The Earth Is Too Heavy

Now, what is this solid earth made up of? All of its material that we can know of by direct observation is that which makes up not more than about ten miles below the surface, what is often called the crust. The rocks that compose this crust have been pretty well studied and their general average composition has been calculated. But what lies beneath the crust and what sort of material is there at the very center of the earth?

One clue is given us by the density of the earth as a whole. It is about five and a half times as heavy as water. The average surface rock is only about one half this; that is, two and three quarters times as heavy as water. There are but two explanations for this discrepancy. One is that the tremendous pressure beneath the surface compresses the rock in the interior so much that it becomes heavy enough to account for the great density of the earth. But some recent experiments have shown that while all rocks do become more dense under pressure, they cannot be compressed sufficiently to make the earth as heavy as it is known to be. The other alternative, and that which we are driven to accept, is that the interior of the earth is composed largely or wholly of material that is much more heavy than the rocks of the surface, irrespective of pressure.

The heavy substance that suggests itself as probably, if not certainly, the most abundant is metallic iron. There are many reasons for this belief. The earth acts as a huge magnet and iron is, by far, the most magnetic substance known. Iron is the fourth most abundant element in the rocks at the surface, that is, in the outer crust. Iron has a high melting point and great strength, so that it is fitted to withstand the tidal and other pulls on the earth's interior.

Another reason why we are led to believe that



Brown Brothers

HOW EARTH WAVES ARE MEASURED

This seismograph, installed at the American Museum of Natural History, New York City, is designed to record tremors sent through the earth by earthquakes. From such records one can deduce many facts about the internal character of the earth

iron constitutes most of the interior of the earth is the analogy with meteorites, which are falling ceaselessly out of space upon the earth to the extent of about 40,000 tons a year. These bodies are believed to be fragments of some large planetary mass, probably of a size comparable with that of the moon or, possibly, the earth. They may be fragments of the asteroids—parts of a broken up planet—that revolve around the sun between the orbits of Mars and Saturn. Many meteorites are composed wholly of iron, or, rather, of an alloy of nickel and iron. Others are partly of nickel-iron and partly of stone. Still others, but rather fewer, are wholly of stone.

For all these and some other reasons we now feel reasonably sure that the earth as a whole resembles a huge meteorite, or rather such a body as that of which the meteorites are fragments. We now conceive the earth to be constituted as follows.

At the center is a huge sphere of metallic iron or nickel-iron, which extends rather more than half way to the surface. Near its outer border particles of stony matter occur scattered through the metal. These gradually increase in quantity, while the amount of metal decreases, until the material is about half metal and half stone. From this depth outward the amount of metal decreases and that of stone increases, until the material is stone peppered with small and few specks of metal. Finally the iron disappears and the material is wholly stone at a depth of about one thousand miles.

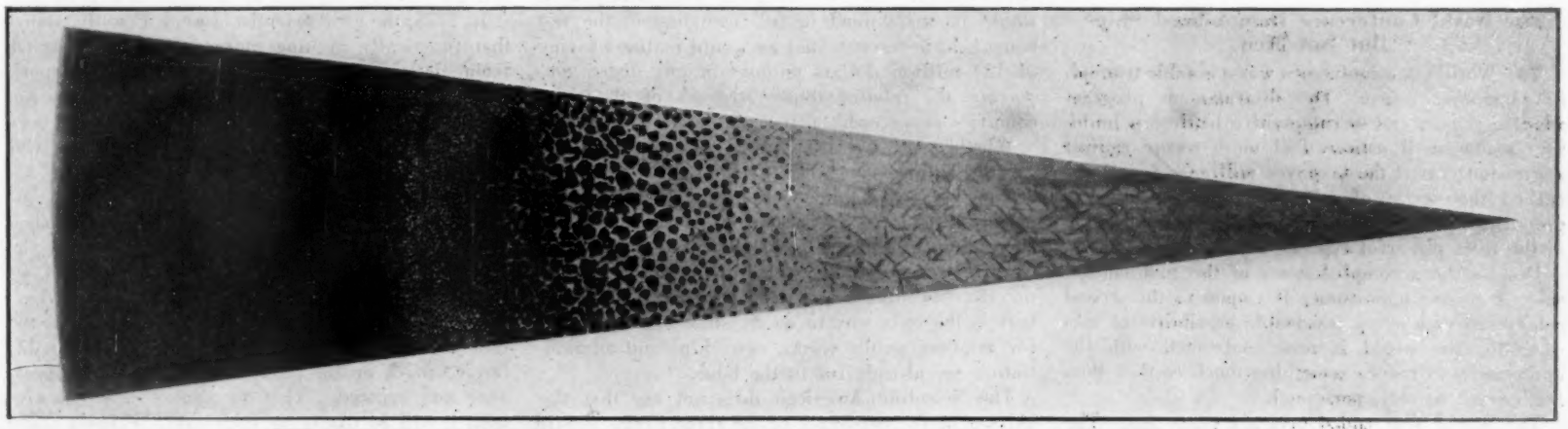
The stone or rock is not uniform. It changes its characters outward, the deepest layers or shells being of very heavy, dense rock, which passes gradually into lighter rock, and finally into a comparatively thin sheet of basaltic rock, similar to that which forms the floors of the ocean. The very light, granitic rocks are at the top. The layers of limestone, sandstone, shale, coal, soil, and other such materials, are relatively so thin that their masses are quite negligible when the composition of the earth as a whole is being considered. The same is true of the ocean waters and the atmosphere.

In estimating the thickness of these different shells or zones the study of two waves from distant earthquakes, which traverse the earth at great depths, gives us much information. It has been found that the velocity of earthquake waves increases steadily with the depth down to a certain depth. Below this depth the velocity remains pretty constant, again down to a certain depth. Below this the velocity becomes less and less. This behavior of earthquake waves is in harmony with such a constitution of the earth as has been described. It is, indeed, one of the chief reasons, in connection with the analogy with meteorites, why we believe the earth to be made up of successively changing and heavier shells surrounding a metallic core.

Nearly Half Iron

Having estimated, by the help of earthquake waves, the average thickness of the several shells and of the core, and combining these with what we know of the composition of meteorites, we can arrive at a pretty fair idea of the chemical composition of the whole earth. It is found that iron is the most abundant element, making up 40 percent of the whole earth. After it in abundance come oxygen, silicon, and magnesium, in the order named. These four elements together make up about 91 percent of the earth. With three others, nickel, calcium, and aluminum, they make up 98 percent. Indeed, twelve elements constitute 99.8 percent of the earth, leaving only two-tenths of one percent for all the seventy or more other elements, among them some of our most widely used and most common metals, such as copper, lead, tin, and zinc.

All these common and useful metals are present, even in the surface crust, in such small amounts that they cannot be detected in most rocks and are made available for our use only by processes of natural concentration into what we call ores. Civilization is dependent in great part on infinitesimal proportions of some of the elements in the earth.



THE PROBABLE NATURE OF A SLICE CUT OUT OF THE EARTH, FROM CIRCUMFERENCE TO CENTER

At the center of the earth there is probably a mass of iron alloyed with a little nickel. Outside this is a zone of mixed iron and rock. Still farther outside are successive zones of different kinds of rock. A relatively very thin layer on the surface represents the visible crust. This is composed, in the main, of rocks somewhat different from those farther below.

Our Point of View

Unjust to the Wright Brothers

THOUGH we may not approve of the decision of Orville Wright to send the first successful flying machine to a British institution for safe keeping, we must confess that the motives which prompt his action are based upon very substantial grounds. The editor of this journal recently went to the Smithsonian Institution to look at the Langley flying machine, the placard upon which has so greatly disturbed Mr. Wright; and this is what he read: "Original Langley Flying Machine.—The first man-carrying aeroplane in the history of the world capable of sustained free flight. Invented, built and tested over the Potomac River by Samuel Pierpont Langley in 1903. Successfully flown at Hammondsport, New York, June 2d, 1914."

Now, anyone unacquainted with the history of the development of aviation, would conclude from the above statement that the machine which he was looking at was the first to make a successful flight with a man aboard, and that it did this over the Potomac River in 1903. As a matter of fact, the Langley aeroplane of 1903 never made any successful flight over the Potomac at that time, and its performance when it was launched for flight seemed to indicate that it was lacking in longitudinal stability. Immediately after its release from the launching platform it dived into the Potomac and, if we remember rightly, in a second test it showed the same lack of control. Eleven years later, it was taken up to Hammondsport Field, fitted with a modern engine and with floats; and after certain readjustments of the machine, it did make a short flight over the lake with Mr. Curtis aboard. The fact that, eleven years after the first unsuccessful tests, the readjusted machine did fly certainly does not entitle the Langley machine to be credited with being the first man-carrying, power-driven aeroplane to make a successful flight. That distinction belongs to the Wright brothers who, after a long study of the principles of flight made with a gliding machine at Kitty Hawk, installed an engine and made what is universally admitted to be the first successful flight in a power-driven, man-carrying machine.

The whole matter, indeed, may be regarded as very much of a tempest in a teapot, and it could easily be set right if the Smithsonian Institution would remove the objectionable placard and change it so that there could be no possible misunderstanding.

The Naval Conference Demobilized Ships But Not Men

THE Washington conference was a notable triumph in promoting peace. The disarmament program adopted put an end to competitive battleship building; made small nations feel more secure against aggression; saved the taxpayer millions of dollars; curbed the desire of militarists for greater war preparation; and ended the menace of competition in the most powerful type of naval vessels.

Despite the accomplishments of the first conference, a greater opportunity lies open to the second conference with every reasonable possibility of success: for the world is now confronted with the opportunity to reduce something much costlier than battleships, namely, personnel.

The World War ended over six years ago. The German navy is gone. There is no Russian navy. Other navies are immobile because they have no money to keep ships in active commission. The German army is one-sixth of its pre-war size. There is no longer any menace in sight; for the Japanese bogey is a bogey in very truth—a sprite begotten of fear and hatred and nourished at the breast of a vicious propaganda. Great Britain is giving every evidence of her desire for friendly cooperation. Nevertheless, we are now maintaining a Navy of 105,000 men (sailors and marines) and more than 9,000 officers, double the pre-war size and costing nearly 300 million dollars a year. The British maintain an equal or even greater force. We have scrapped battleships. Not yet have we demobilized our war personnel. If personnel were reduced proportionately to the reduction of ships, the *relative strength* in ships and men would remain the same, and the saving to the tax-burdened nations would be fully $300,000,000 per annum.

Economics of the Next Naval Conference

THE naval bill which went through last winter requests the President to call another conference "by which armaments shall be effectually reduced and limited in the interests of the peace of the world, and the relief of all nations from inordinate and unnecessary expenditures for armaments and preparation for war." Our Appropriation Bill for the fiscal year 1926 carries the following items:

Personnel	$174,000,000
Operation and upkeep of ships	74,000,000
Aviation	15,000,000
Public Works and repairs of Yards and Docks	9,000,000
Increase of Navy (new ships construction)	7,000,000
All other items (administration, War College, etc.)	8,000,000
Total Budget	$287,000,000

It is evident that if any considerable reduction in expenditures is to be made, it must be in the first two items of "Personnel" and "Operation and Upkeep of Ships." The present ratio of strength of the United States, Great Britain and Japan is 5-5-3. It has been suggested that if the personnel, or pay expenses, and those for keeping our ships in full commission were cut in half, in each navy, and the ratio were renamed 2½-2½-1½ it would be possible to save at a stroke 87 million dollars in the pay bill and 37 million dollars in the operation and upkeep of ships. For with the personnel cut in half, eventually only half as many ships as at present would be maintained in full commission, the rest being held in reserve; and we would realize a saving of 124 million dollars *without in any degree impairing the relative treaty strength* of the three countries concerned.

Whether such a drastic cut is desirable or no, it is for the nations concerned to say. The mere suggestion of such a thing would, of course, arouse a perfect tornado of opposition, not only in our own Navy, but in those of Great Britain and Japan. Nevertheless the thing is logical. If we want to prevent "inordinate and unnecessary expenditures," here is the only way to do it; since appropriations for aviation, public works, new ships and administration are already cut to the bone.

The Scientific American does not say that this halving of the personnel of the three navies should be done. We merely offer the suggestion for the serious consideration of our readers. Think it over!

How Far by 1950?

ASTRONOMY is the oldest science. Yet, owing chiefly to the perfection, within comparatively recent years, of new instruments such as the photometer, the heliometer, the spectroscope and the interferometer with which the diameter of distant suns has recently been measured, and the new knowledge we have learned through their efficient use, our acquaintance with the universe may fairly be said to have been acquired chiefly since the beginning of the present century. What further progress in astronomy may we anticipate, then, before 1950?

This interesting question was asked and answered by Dr. Heber D. Curtis of the Allegheny Observatory, Pittsburgh, in an address before the American Association for the Advancement of Science. Some new method or some new instrument may change the science of astronomy as completely as the discovery of the spectroscope has already changed it. For example, suppose we should find out how to make a photographic plate one hundred times as sensitive to light as the most rapid plate which we now have, uniformly sensitive to the whole spectrum from the ultra-violet to the infra-red—what would be the effect of this apparently commonplace discovery on our knowledge of the universe? It would have, says Dr. Curtis, the same effect as if we were to replace the thirty-six inch objective glass of the great Lick telescope with one of thirty *foot* diameter!

Nowadays the astronomer seldom sits his weary vigil at the eyepiece as of old. The use of the photographic plate permits him to retain the image of a given faint star on one spot long enough for it to register its image—sometimes several hours. Thus the effect is cumulative. Logically, then, if a faint star can be thus made to register by several minutes' exposure of the plate, an extremely faint star should register after a much longer exposure.

This, unhappily, is not always the case. There is a certain minimum strength of light which is required to make any impression at all on the plate, no matter if the exposure be extended to any length.

Many times in the past some particular branch of science has apparently reached the limits of the extension of its knowledge, only to be given new life by an unanticipated discovery such as that of a more sensitive photographic plate would be. This was the case with physics. Near the end of the last century the physicists believed they had practically exhausted the research to be done in that science. Yet the discoveries of the X ray and of radio-activity suddenly opened up a whole new field.

In 1775, the great scientist, Joseph Priestly, stated that practically nothing more was to be expected from electricity! The familiar laboratory experiments with static electricity were then well known. Nothing else remained to be done with the new and mysterious fluid. Electricity as a science was surrounded and thoroughly exploited.

So with astronomy. Our useful powers of telescopic magnification now seem to have reached almost the final limit and we stand baffled by the limitations of the photographic plate. Should we then give up hope? On the contrary.

On the analogy of the past in science, now is the time to expect that some new, perhaps widely different, attack on the problem will make its appearance and succeed. That we cannot now conceive what it will be like is not important. Priestly could not conceive of the dynamo. Nor could Faraday conceive of the radio.

The Cathedral of Learning

THE superb and beautiful structure which graces this page might be taken, at first sight, for one of the towering office buildings, which are the latest and certainly the most distinctive characteristic of the modern American city. That it has been built to house the activities of a great university is the last thought to enter one's mind. That, however, is its purpose, and, most appropriately, it is to be called the Cathedral of Learning. The plan is certainly as novel as it is daring; but in determining to house the University within a tower nearly 700 feet high, the trustees of the University of Pittsburgh were prompted by considerations of local history, of art and sentiment, and by the demands of rigid economics.

The Cathedral of Learning will speak of the strength, aspiration and accomplishment of the past and present citizens of the greatest center of the steel industry in the world. That it is highly artistic no one will deny; and in its massive, yet well-balanced and aspiring proportions, it will commend itself to the artistic feeling and sentiment, not only of the people of Pittsburgh, but of the world at large. Historic interest and emotional symbolism, moreover, are not gained at the expense of economics; for the tower form was adopted as being at once the most convenient and economical solution of the problem.

Tower Covers Less Than Two Acres

The land that is owned by the University covers about fourteen acres. If the space needed by the University were created in four-story buildings, they would entirely cover this area, whereas the rectangular area covered by the base of the building measures only 260 by 260 feet. Hence, when the building is completed, there will remain more than twelve out of the fourteen acres for the erection of such buildings as may be required in the future.

The central tower portion is approximately ninety feet square. The wings, which give a very fine buttressing effect to the building, are fifty-four feet in width and vary in length from forty to eighty feet. The highest point of the tower will be exactly 680 feet above the ground line.

The present floor space of the existing University buildings is 292,800 square feet. The floor space required in all the schools of the University, except medicine and dentistry, is 427,000 square feet, and 320,460 square feet are needed for medicine and dentistry. When the tower building is completed, it is proposed to turn over the existing structures to these schools and ultimately provide additional space for them.

Provides for Future Growth

As to the future, should there be an annual increase during the next five years of seven percent, 529,000 square feet will be required in 1930; and this space will be provided in the proposed high structure, which will house the College and the Schools of Engineering, Mines, Business Administration, Education, the Graduate School, the School of Law, the School of Pharmacy, in addition to the libraries, the rooms for assemblies, debating, dining, and administration rooms.

The Cathedral of Learning as thus described will provide accommodation for 12,000 students. The cost of the building as here shown will approximate ten million dollars, and the saving in land by utilizing tower construction is estimated at from $1,300,000 to $1,500,000. Twelve elevators are provided, and it is estimated that their operation will cost about $14,775 a year. The adoption of the tower type also means economy in heating. The estimated saving over an equal heating capacity in several four-story buildings is $15,000 per year.

The architect of the building, Mr. Charles Z. Klauder, is to be congratulated on his treatment of a difficult problem. The style is fundamentally Gothic; but it is modified to meet the requirements of so vast a structure. The decorative effects are sparingly applied, and the building is permitted to express its great height by the unbroken sweep of its vertical lines.

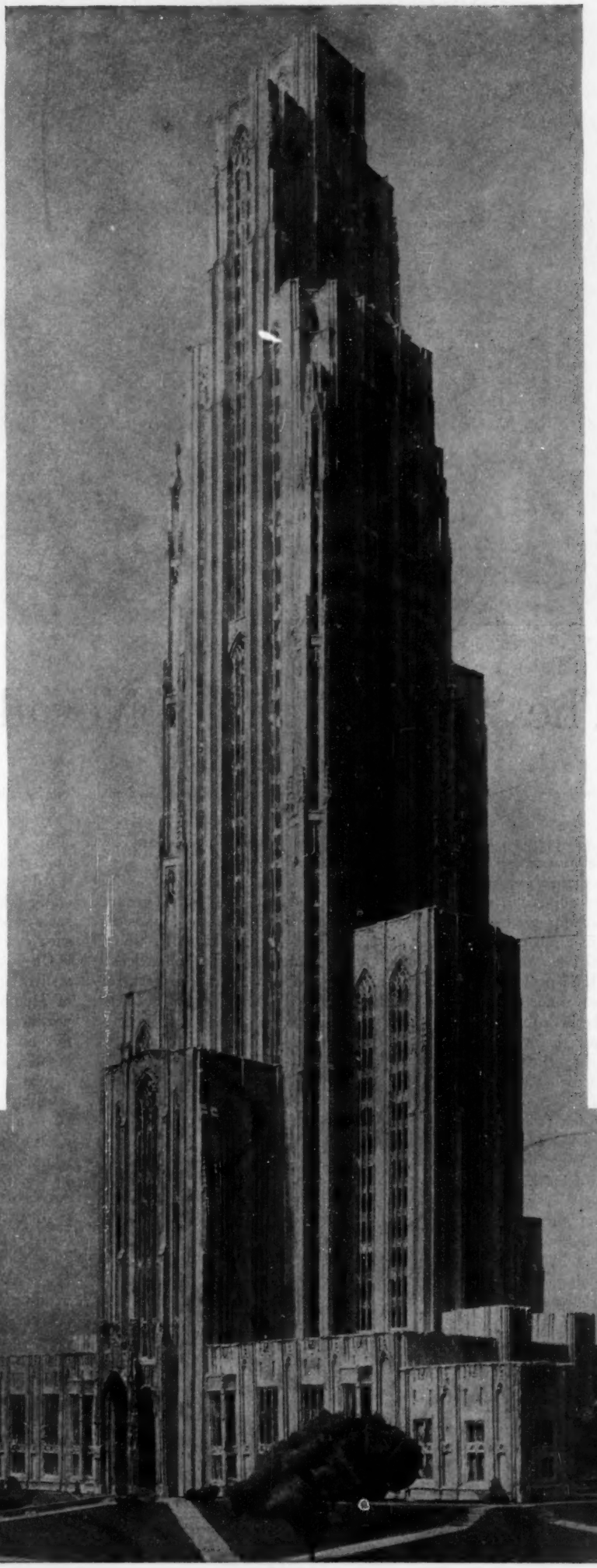


Photo by Louis Schellbach 3rd

First stage of true Pueblo architecture

The "Lost City" of Nevada

By M. R. Harrington

Archeologist in Charge of Nevada Expedition Museum of the American Indian, Heye Foundation

BURIED under shifting sands beside Muddy River, near the little Mormon town of St. Thomas, in southern Nevada, and scattered over the adjacent barren ridges along the foot of Mormon Mesa, lie the crumbled ruins of an ancient settlement, now officially known as Pueblo Grande de Nevada, or simply as the "Lost City." It is probably one of the oldest towns in North America north of Mexico, and doubtless flourished before the famous cliff-dwellings were built, and long before the prehistoric stone-built cities and villages, whose ruins still fascinate the tourist in New Mexico and Arizona, were founded or even thought of.

Here, since November, 1924, an expedition from the Museum of the American Indian, Heye Foundation, in New York, has been delving among the foundations, the fallen adobe walls, the tombs and the ash heaps of the ancient community. The work may be continued for months to come, but already relics have been uncovered and information secured, that will write a new chapter in the early history of the Pueblo Indian tribes, and in so doing, will shed a much needed light on the beginnings of civilization in ancient North America.

Indians Lend Their Aid

Although rumors of the presence of ruins in this district have been afloat for years, credit for the present discovery is due to Messrs. Fay Perkins and John Perkins, brothers, residents of the district, and prospectors by profession. They alone, of all the people who had doubtless seen them, recognized that the broken fragments of pottery and the outlines of old buildings might have a story to tell, and what is more, took the trouble to report them to Governor J. G. Scrugham of Nevada. And it was Governor Scrugham who invited the writer to accompany him on a reconnaissance trip.

This was in October, 1924. By the end of November a full-fledged expedition was on the ground, working in cooperation with the state authorities. Today our party includes C. O. Turbyfill, who is also a member of the Museum staff; Louis Schellbach, 3rd, artist, photographer and map expert, representing the state of Nevada, and last but not least, our capable Pitt River Indians, George Evans and Willis Evans his son, both members of the Nevada State Police. It seems truly fitting that Indians should take part in an expedition of this sort, especially when Indians can be found who will take such a personal interest in the work, and will give such careful and intelligent service.

Photo by M. R. Harrington

A TWO-THOUSAND-YEAR-OLD SKELETON

The graves of these ancient people were always found under or near the pit dwellings

On looking over the ground we found that the ancient settlement lies scattered along the east side of Muddy River from a point opposite St. Thomas northward nearly to Overton, a distance of between five and six miles, with a greatest width of about a mile, although it was doubtless somewhat wider, before numerous house-ruins were destroyed in leveling the land for cultivation. Over this area, be it understood, the traces of old houses are not continuous as in a modern city, but are scattered, sometimes with considerable gaps between.

Arts of Weaving and Dyeing Were Known

Due to the lapse of so many centuries—fifteen or twenty of them at the least—and to the fact that the walls were built largely of rude, sun-dried, loaf-like bricks of adobe, little is left of the houses where exposed to the weather but a low heap or mound of rocks and adobe clay, which may be identified only by the practised eye as a one-time human habitation. A little careful digging with trowel and brush, however, reveals the true character of these heaps, and exposes to view the ground-plans of the ancient dwellings.

The best preserved of the houses may be found under the dunes, where the wind has piled up about them a covering of desert sand, which has protected the remnants of the walls to a certain extent.

About thirty houses have been laid bare at this writing, ranging from little one or two-room affairs, which naturally are the most numerous, to quite

Photo by Louis Schellbach, 3rd

EXAMPLES OF POTTERY VESSELS

It was by means of the thousands of fragments of this pottery that the ruins were identified as Pueblo

pretentious buildings, one of which contained twenty-one rooms. During this excavation work in the houses numerous specimens of the handiwork of their occupants came to light, mostly in the way of stone and bone implements, pottery, and ornaments of turquois and shell. These we discovered both on the floors of the old rooms and in the graves of the people themselves, which are always found in or near the houses.

From these specimens we have built up quite a picture of the life of this forgotten people. For example, from charred seeds and corn-cobs found in the ruins, we learn that they not only gathered wild natural products of the desert, such as mesquite-beans and screw-beans, but that they also farmed the lowlands of the valley, and raised corn and beans and squashes. Probably they irrigated their crops, unless the climate was much moister than it is now; certain it is that the early Mormon settlers found traces of old irrigating ditches when they first began to clear the land.

For meat the people were obliged to hunt the deer, the mountain sheep and the jack-rabbit, as they raised no domestic animals except the dog. They were not heavy meat-eaters, for the bones of the game-animals are not numerous in the ash-dumps or "kitchen-middens" about their old homes.

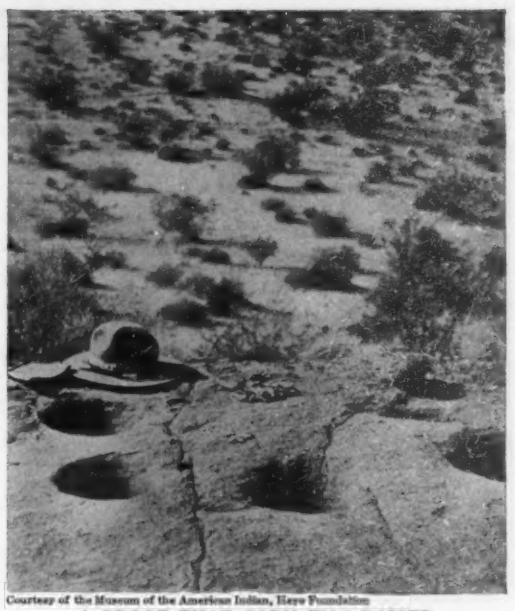
Considerable progress had been made in the art of weaving. We have succeeded in saving a few crumbling bits of fine woven cloth from the scant vestiges of garments sometimes found in the graves, and we rescued several shreds of similar material, better preserved, from the dusty rubbish in a little cave within the Pueblo. These fragments reveal the interesting fact that cotton must be added to the list of agricultural products, and they prove that the art of dyeing textiles had been discovered. Some of the pieces, in texture like cheese-cloth, still showed traces of color, red and blue and purple.

This thin fabric served for lighter garments; for blankets commonly used as bedding, and serving as overcoats in cold weather, thick, warm, fur-cloth was woven in abundance. The first step in making this was to cut the furry skins of rabbits or other animals into long, narrow strips, which were then twisted and woven into blanket form. Pieces of such fur cloth blankets are commonly found in the graves. Sometimes traces of an even more interesting textile appear, and that is feather-cloth. This must have required a great deal of time and labor. It was necessary first of all to gather and prepare fiber, then twist it into strings, and then to wrap these strings with downy feathers until a soft fluffy yarn was produced, resembling marabou, only not so thick. Then came the less tedious labor of weaving this yarn into a blanket.

Pottery Helps to Define Period

The patience and skill still shown by Pueblo jewelers may be seen in the beads of shell and turquois, neatly drilled and rounded; and by pretty pendants of turquois and selenite and shell. This shell all came from the Pacific Ocean, and this means intertribal trade through the wild canyons of the Colorado, or across the high Sierras and the parched expanse of the Amargosa Desert, perhaps across the grisly depths of Death Valley itself. The turquois seems to have come from the ancient mines near the Colorado River, but whether it was dug from the hillside by the people of Pueblo Grande themselves, or whether they got it by trade can not yet be determined.

Their arrow-points, drills and knives of many-colored flint show that the art of chipping stone had reached a high stage of perfection. The *metates* or grinding slabs for corn are well made, but the



Courtesy of the Museum of the American Indian, Heye Foundation

A PROOF THAT CORN WAS RAISED

These (mortars) holes were used for grinding corn. They were made in the living rock near Pueblo Grande

grooved stone axe, so common in most later Pueblo ruins, is conspicuous by its absence. And indeed no axes of any kind whatever have been found anywhere in the Pueblo up to the present writing.

Literally thousands of fragments of pottery lie scattered about the sites of the old houses, and these, together with the whole vessels frequently found in the graves and occasionally in the rooms, are proving of great value to our study. It was by their means that we were able to identify the ruins as Pueblo in the first place, and the pottery has also helped in figuring out the period to which they belong.

Plain pottery, usually black, is very abundant, but this furnishes little clue to the identity of its makers. It was only when we had secured examples of bowls and jars of white, and gray and rich red color on which tasteful designs had been drawn with black paint, and had in addition, discovered pottery in which the decoration was worked out by varied corrugations of the outside surface, that we were able to say definitely that the "Lost City" was built and populated by Pueblo Indians.

Taking the pottery as a whole, while its resemblance to Pueblo ware in general is unmistakable, there are certain characteristics which stamp it as

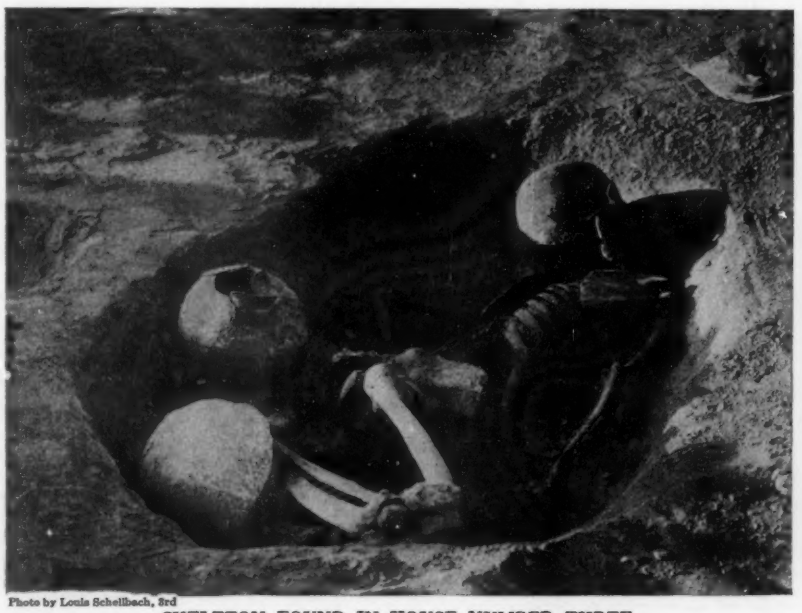


Photo by Louis Schellbach, 3rd

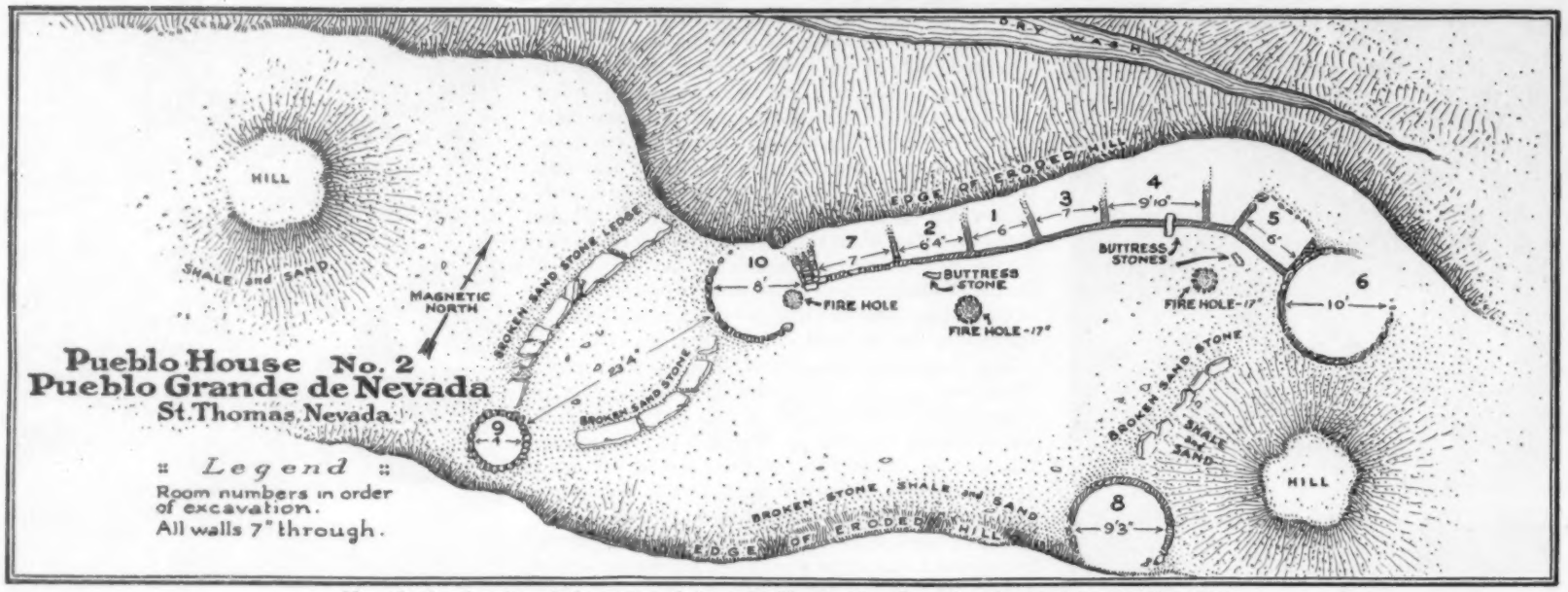
SKELETON FOUND IN HOUSE NUMBER THREE

Pottery bowls were found intact in most of the graves. Perhaps this points to the ancient custom of burying food with the dead

Courtesy of the Museum of the American Indian, Heye Foundation

AN IMPORTANT STEP IN IDENTIFYING THE RUIN

Mr. E. J. Bush, member of the Scientific Staff of the Museum of the American Indian, Heye Foundation, restoring pottery vessels found in Pueblo Grande



Map showing location of the various finds at Pueblo Grande. From data furnished by Mr. Harrington

belonging to an early period of Pueblo history.

But the best indication of the great age of Pueblo Grande de Nevada lies in the character of the houses. We find here Pueblo architecture in its earliest stages, and even the primitive type of dwelling occupied before this development began, all in the same Pueblo. This is perhaps our most important find.

The most primitive dwellings yielding Pueblo pottery were oval pits dug down into the earth to a depth of two or three feet, and measuring eight or ten feet in length, with a width of six or eight feet. These were floored with adobe, and the dirt walls of the hole were neatly plastered with adobe. But in many cases the walls from the surface of the ground upward must have been made of poles and matting or something perishable, for such pits frequently appear filled only with wind-blown sand without a trace of rocks, adobe or other fallen wall material.

This is the first and oldest stage represented at Pueblo Grande. The next stage is also a "pit dwelling" similar to the first, but with the addition of a substantial encircling wall of adobe, or adobe and stone, which has fallen into the pit.

The next step was to place the pit dwellings side by side in a row. Some prehistoric architect discovered that if the pits were placed near enough together, and made rectangular instead of oval, a single common partition wall would answer for two adjoining pit-dwellings, and the idea of building a single house with a number of rooms followed naturally. Before Pueblo Grande was abandoned, one-story houses of many rectangular rooms, with floors at or near the level of the ground were being built, and Pueblo architecture was born, although the idea of constructing huge stone communal dwellings several stories high, with hundreds of rooms, was not evolved until centuries later.

No Race of Seven-foot Giants

The house types and the pottery found at Pueblo Grande enable us to fit our city into the classification of southwestern archeology worked out by Dr. A. V. Kidder, who divides what might be called the pre-history of the region into periods, of which the oldest was that of the basket-makers, who flourished about 2,000 B.C., a people who had learned to raise corn and squashes but were ignorant of pottery and house-building. The next period was that of the post-basket-makers, who seem to have invented pottery or, at least, were first in the region to use it. Then came the pre-Pueblo period when the people developed the types of pottery we call Pueblo, raised not only corn and squashes but beans and cotton as well, and wove good cloth, but still lived in semi-subterranean "pit-dwellings." The next period may be called early Pueblo, in which real houses were built with two or more rooms and the pottery was improved to a noticeable extent. After this came the great period of Pueblo pre-history, the period of the huge communal stone houses and the highest development of Pueblo civilization. Then comes the late prehistoric period, and finally in the middle of the 16th Century the conquest of the Pueblos by the Spaniards.

Into this scheme we may place Pueblo Grande de Nevada about the close of the pre-Pueblo period and the beginning of the early Pueblo period; which was probably about the time of Christ, or possibly somewhat earlier, but the exact time may very likely never be known.

Such are some of the outstanding facts concerning the "Lost City of Nevada." Notwithstanding newspaper reports to the contrary, we have found no "race of seven-foot giants" and make no claim that our Pueblo is "ten thousand years old." We do think, however, that here in the valley of Muddy River, perhaps 2,000 years ago, the ancestors of some modern Pueblo tribe learned how to build permanent buildings, to weave fine cloth, to make good pottery, to improve their agriculture, in brief, developed the arts which, in after years, made Pueblo civilization one of the highest in ancient America, north of Mexico.

Courtesy of the Museum of the American Indian, Heye Foundation

EXPLORATION PARTY AT SITE OF RUINS

The author of this article is second from the left and Governor Scrugham, who was of great assistance in the work, stands next

Courtesy of the Museum of the American Indian, Heye Foundation

ROCK CARVINGS FOUND NEAR PUEBLO GRANDE

The significance of these carvings made by the ancient inhabitants of this "lost city" is as yet unknown

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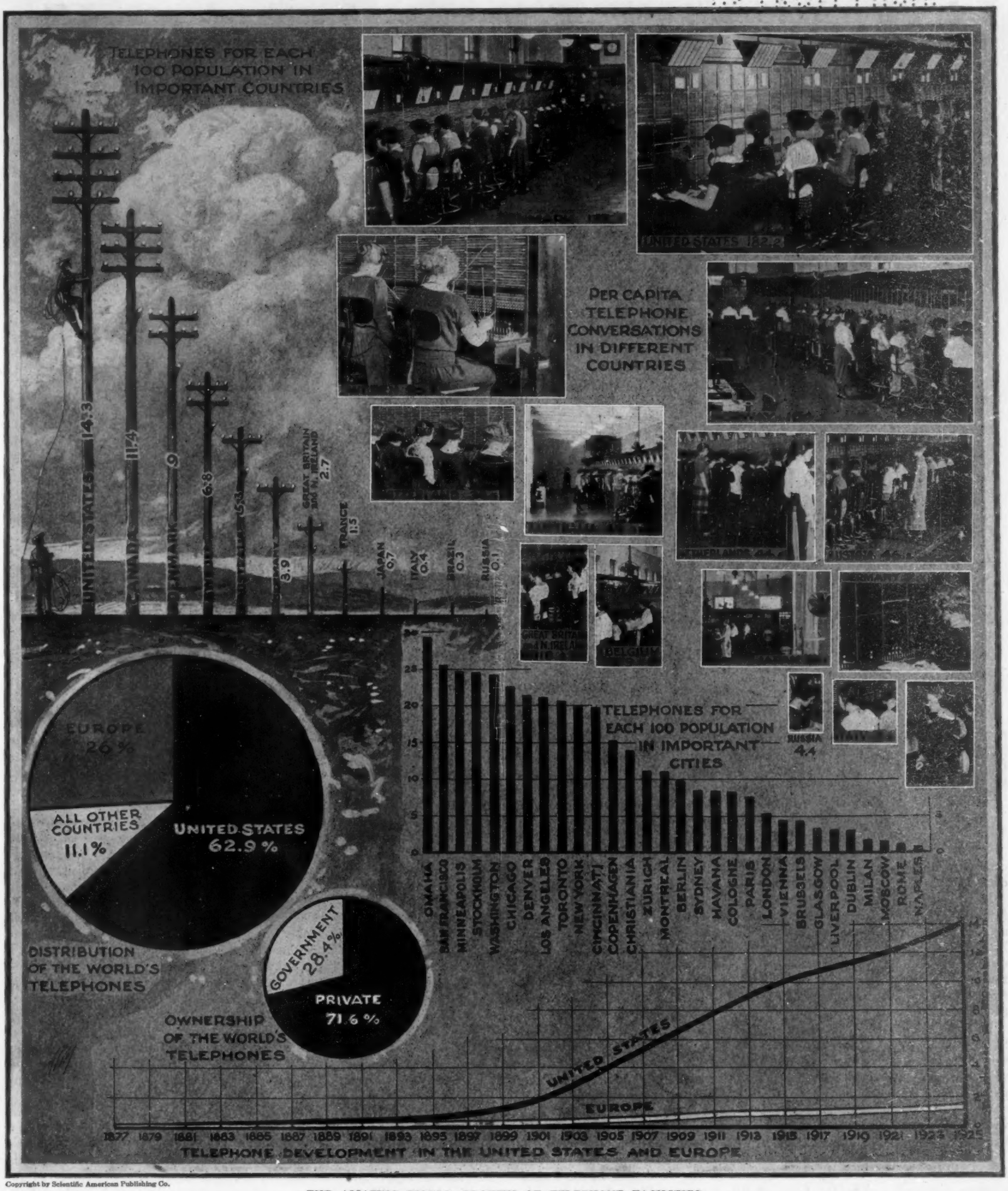

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THE AMAZING WORLD GROWTH OF TELEPHONE FACILITIES

Strange tongues are heard over the wire. Girls say "Hello" or "Are you there?" or their equivalent, and you can talk over family matters or business or make engagements of a more pleasant variety. All you do is to raise the receiver off the hook, and the invisible system does the rest. Yet people vary in the use of the telephone. The average person in the United States sends 182 messages a year, the inhabitants of little Denmark send 123, while the Russians are content with four and one-half calls. The "graphs" and the scaled pictures of exchanges tell the story. Each picture of an exchange is proportionate to the telephone conversations in each country. Through the courtesy of the American Telephone and Telegraph Company we have secured unpublished figures from which our staff artist, Mr. Arthur T. Merrick, has prepared this page.

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PATENT DEPT

Courtesy of Radio Corporation of America

Enjoy Your Radio "Far from the Madding Crowd"

New Portable Sets and Land Wire Connections Between Broadcasters Make Radio Entertainment Popular in Summer as Well as Winter

By Orrin E. Dunlap, Jr.
of the Scientific American Staff

THE general impression for the past five years has been that a practical, simple device, easily attached to a receiving set to filter out static interference would be the greatest boon to summer radio. Time is proving that this is not altogether true. There are more reasons than one for the decline in radio interest in July and August. Most of the causes for the summer ebb in radio are being overcome.

Interference produced by atmospheric electricity is not as serious as many believe. Static has won a bad name because the majority of broadcast listeners attribute and classify every hum, howl and scratchy noise to the strays. Static is not responsible for all freak noises, nor is it entirely responsible for a decline in the radio business from April 1 to October 1.

Radio sails along in all its splendor from October to the first fine days of spring. Then it begins to slow up. There are various reasons. This year the volume of letters received by radio editors of newspapers, and at the broadcasting studios plainly showed that the sudden drop came during the first week of April. Static could not be blamed because there was very little static at that time.

It was the balmy spring air that attracted radio fans away from their sets and out-of-doors to the gardens, highways and fields. Gasoline filling stations reported a great increase in the sale of fuel and motor oil on the week-end of April 5th, and simultaneously the radio stores noticed a sharp decline in business.

Since broadcasting started in 1920, manufacturers and dealers have realized more and more each year that summer radio must be linked up and allied with outdoor activities and vacations. It will not be long now before a picnic will not be complete without radio entertainment.

This summer will prove the value of owning a radio outfit more than any previous vacation season. Heretofore, there has been but one or two real portable, multi-tube, sensitive and selective receivers on the market. The majority of receivers have been semi-portable and heavy. This year there is a complete superheterodyne, weighing only 37 pounds and another built in a suitcase. The adjustable loop antenna, loudspeaker, batteries, and all equipment is compactly arranged in the cabinet. The new models are so complete, and easily operated by two dials, that they intercept concerts for motorists and campers alike. A long-wire antenna and ground connection is not required. So sensitive are these sets that a motorist camping over night near the cataract of Niagara can readily expect to hear jazz or dinner music from a New York or Chicago hotel.

Great Increase in High-power Stations

The small loop antenna used with portable equipments has many advantages that make listening in a delight in the summer. The loop is small, and unlike a long antenna, stretched in the air, will not pick up as much static. The loop is directional. When it is pointed toward a station it receives with maximum intensity, but waves striking the loop broadside are excluded. This minimizes interference, and coupled with the fact that the superheterodyne is recognized as the sharpest tuner of all receivers, tends for no overlapping of stations.

The development of the superheterodyne circuit in portable form will undoubtedly lead to the appearance of other portable types on the market next year. However, there is not likely to be as many varieties of portable sets as ordinary receivers, because all circuits cannot be built compactly. Furthermore, it requires a multi-tube set to operate successfully in connection with a small loop. The vacuum tubes are operated by dry cells, thus the cumbersome storage battery and the trouble of charging it are dispensed with and portability is featured.

The summer vacationist this year will not be forced to lug along a big loudspeaker horn, coil of antenna wire, storage battery and a heavy receiver. The new and complete portable outfits solve one of the problems of summer radio. These sets are not limited to summer use but are built so that permanent installations can be made in the home, thus they are serviceable throughout the year.

When broadcasting encountered its first warm weather in 1922, the transmitting stations were all of much lower power output than those in operation today. It is a well known fact that daylight greatly reduces the range of a radiophone station and for that reason unless the radio fan of 1922, and the two years that followed, stayed up until after midnight he had little chance of hearing a station over 100 miles away. Then the static dominated, because the Hertzian waves of "the good old days," were

Courtesy of Operadio Corporation

THE QUIET STILLNESS OF A MOUNTAIN LAKE

What could contribute more to the peacefulness of a summer evening on a placid lake than strains of music coming from some distant and unseen choir of voices?

Courtesy of Radio Corporation of America

ON WITH THE DANCE!

One doesn't need to take an orchestra to the mountains, nor does one of the party have to give up dancing to play for the others. Just turn the knob and the jazz will come!

weak; receivers were less sensitive and the static had an opportunity to be prominent.

This season finds the picture vastly changed. Instead of 100 to 500-watt broadcasters there are about thirty 1,500-watt stations, and the majority of them have reserve power up to 5,000 and 10,000 watts, ready for use should government power restrictions be lifted. Numerous stations have already been authorized to increase their output to 2,000 watts for the summer season. The second line of defense consists of stations ranging from 500 to 1,000 watts. There are about one hundred and ten 500-watt transmitters. The high-power stations can penetrate daylight to a greater extent, drown out static and in many instances make the atmospheric electricity scratches less noticeable than the slight rasp of a phonograph needle.

Few vacationists this year will be out of range of at least one broadcasting station and the majority will be within tuning distance of New York, as many of the stations are linked with Manhattan microphones by land wires. Thus the effect of daylight and static is further subdued. Station WMAF, owned by Colonel Green, at South Dartmouth, Massachusetts, will be joined with WEAF, New York City, so that vacationists in New England will be supplied with entertainment from the Broadway station. WGY, Schenectady, has power sufficient to blanket every valley and hill in the Adirondacks, and this station is connected by wires with WJZ, atop Aeolian Hall, New York City.

The chain of stations joined with WEAF extend as far west as Davenport, Iowa, so that those recreating in the Great Lakes region and in the Canadian woods can depend upon hearing the New York programs relayed through WGR, Buffalo; WCAE, Pittsburgh; WEAR, Cleveland; WWJ, Detroit; WSAI, Cincinnati; and WOC, Davenport. Supplementing this service will be heard the programs broadcast from Chicago stations, of which there are a plenty. KDKA, Pittsburgh, is another transmitter that can be relied upon in the great vacation area, for news, baseball scores and music.

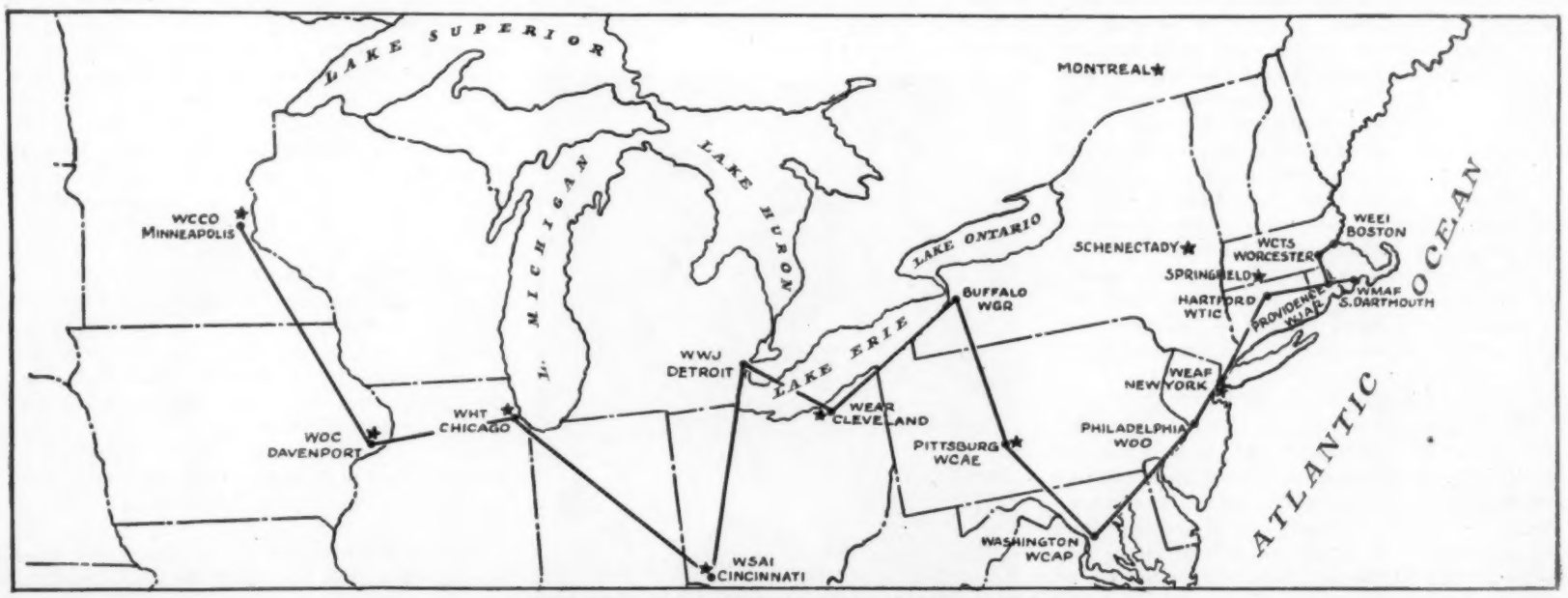
Swimming Lessons by Radio

Vacationists on Long Island and along the Connecticut shore can easily tune in the New York stations direct. Those along the coast of New Jersey are within tuning range of New York, Philadelphia, Atlantic City and Washington.

There will be a host of features on the air during July and August, that will make a radio set worth while. Prominent on the summer program will be the United States Marine band scheduled to entertain through WEAF and WCAP, once a week. There will be plenty of dance music radiated direct from the roof gardens of large hotels and amusement parks. Five summers of broadcasting has taught radio impresarios that radio followers prefer entertainment rather than instruction during the hot weather.

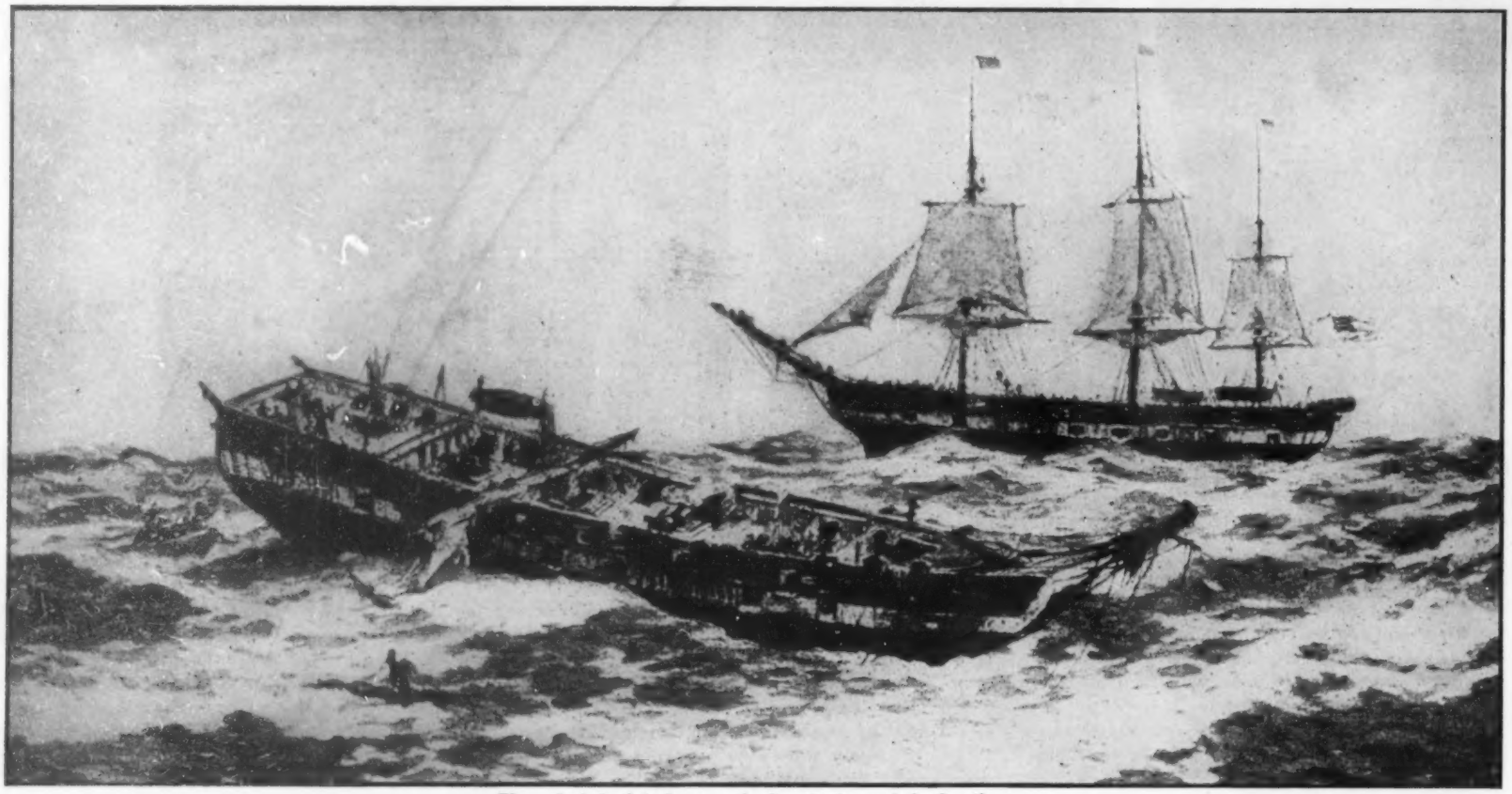
Station WOR, will send out swimming lessons. Setting-up exercises will be broadcast by WEAF and WOR, but they will be modified to suit the warm weather. Talks on summer diet; hot weather dishes; fishing and sports will be featured. The New York University "Air College" will observe the vacation period but Columbia University will broadcast some of the lectures in conjunction with its summer courses.

One big advantage of vacation land is the fact that it is ordinarily far enough from broadcasting stations, that there is no severe local interference to overcome. The vacation trip offers numerous advantages from a radio standpoint, whether one is interested in experimenting or merely in being entertained. The rural districts are free of steel buildings and intricate lighting networks, thus the signal strength is far better than in the city. A listener in the country can generally choose anyone of a fairly large number of stations with freedom.



HIGH-POWER STATIONS THROUGHOUT VACATION LAND

Ten broadcasters with power output of over 1,000 watts are within range of thousand of vacationists. These stations are denoted by stars on the map. A chain of fifteen transmitters linked with WEAF will radiate entertainment from New York



The end of the fight between the Constitution *and the* Guerièrre

The Passing of "Old Ironsides"

A Call to the American People to Save Their Most Famous Ship

By J. Bernard Walker

THIS article is an appeal to the patriotism of the American people. The Fourth of July, with its annual revival of great historic memories is close at hand; and from one of America's most treasured naval relics of Revolutionary days there comes, at this opportune time, a cry for help. The writer felt the force of that appeal only recently, when he stood on a wharf at the Boston Navy Yard and looked upon what is left of that glorious relic of the past, the *U.S.S. Constitution*. In outward form the ship was exactly the same as that upon which our forefathers looked with grateful pride; but when he went aboard and examined the ropes and spars, the massive framing and planking of the ship, it was evident that she was doomed to an early death—an impression which confirmed the statement of the Commandant of the Yard, Rear Admiral L. R. de Steiguer, that unless the American people came to the rescue with sufficient funds for her complete rebuilding from truck to keel (which has been authorized by Congress), the ship must be towed out to a mud bank and burned. Failing this, so rotten were her timbers that she would sink at her moorings.

A Century of Adventure

The *Constitution*, launched at Boston, in 1797, was one of the first three frigates to be authorized under the Constitution of the United States. At the close of the Revolutionary War, our merchant marine began to expand so rapidly that Congress realized it was necessary to have a naval force for its protection. The *Constitution*, *Constellation* and *United States* were the first up-to-date warships to be built by the young Republic. The Constitution went into commission in 1798, saw service in the French War and helped to clear the West Indies and our coast line of the French cruisers. A few years later, we find her bombarding the forts at Tripoli and dictating peace without tribute to four of the Barbary Corsair states. This treaty gave such protection to our commerce that it grew rapidly and brought much greatly needed wealth into the coffers of the United States. Then came the War of 1812, when the *Constitution* won a succession of victories over British frigates and so increased our prestige at home and abroad that secession was averted and the war brought to a close.

DECAYING TIMBERS OF THE CONSTITUTION

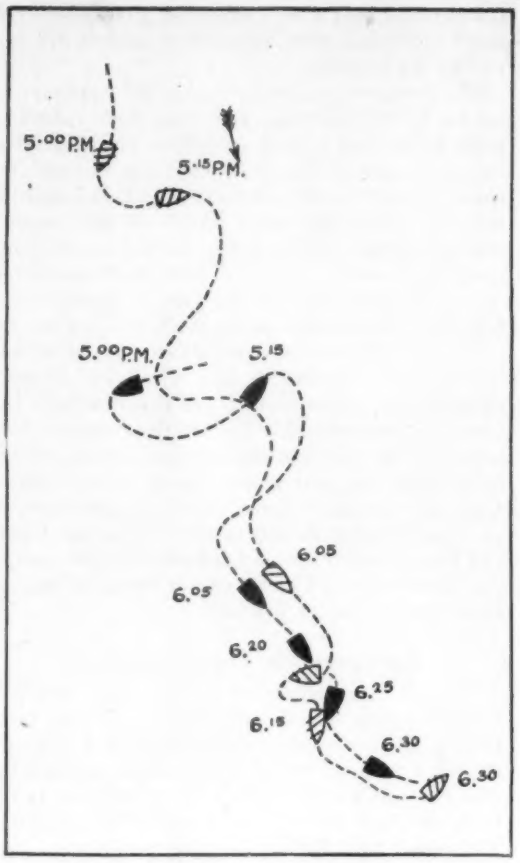
Dry rot has broken away the inside planking, showing the decayed framing of ship

For a period of eighty-four years the *Constitution* was in active commission, until finally, in 1882, she was made a receiving ship at Portsmouth, New Hampshire. From that port she was towed to Boston in 1897, in connection with the centennial of her launching. Here, ten years later, in 1906-7 she received her third reconditioning.

Once Proposed for Target

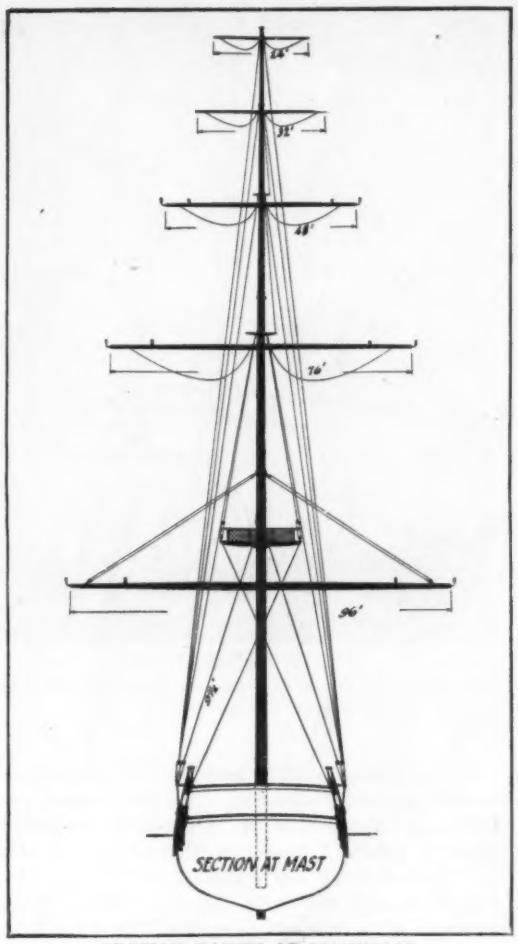
The love and admiration of the American people for their famous vessel is proved by the fact that she has experienced no less than three separate reconstructions. The first came in 1833 and was done at Boston, as one of our illustrations shows. The second reconstruction took place in 1871, when she was rebuilt at the Philadelphia Navy Yard. Then, in 1905, when she was considered unsuited for any naval service or repair, it was recommended that she be used as a target for some of the ships of the North Atlantic fleet and be sunk by gun fire. This aroused such a storm of protest throughout the nation that Congress in 1906 appropriated $100,000 for her rebuilding as closely as possible to her original lines and spar plan. The repairs at that time took place mainly above the upper deck; since the appropriation was not sufficient to allow very much to be done upon the hull itself. In the twenty years or so that have intervened, the timbers of the hull have been so eaten away with dry rot and other decay that only complete rebuilding can save the ship.

The *Constitution*, both in her design and subsequent performance, was one of the most remarkable naval vessels of her time, and we are fortunate in being able to present our readers with a series of scale drawings of her sail plan, and a cross-section



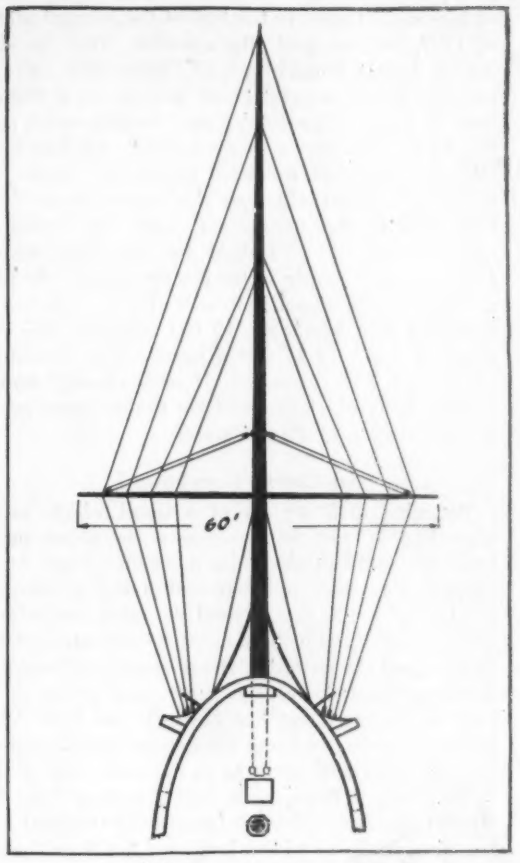
FAMOUS NAVAL ENGAGEMENT OF 1812

Constitution *(white) outmaneuvered the* Guerièrre *(black), crossing her bow and stern and raking the enemy several times. From official chart*



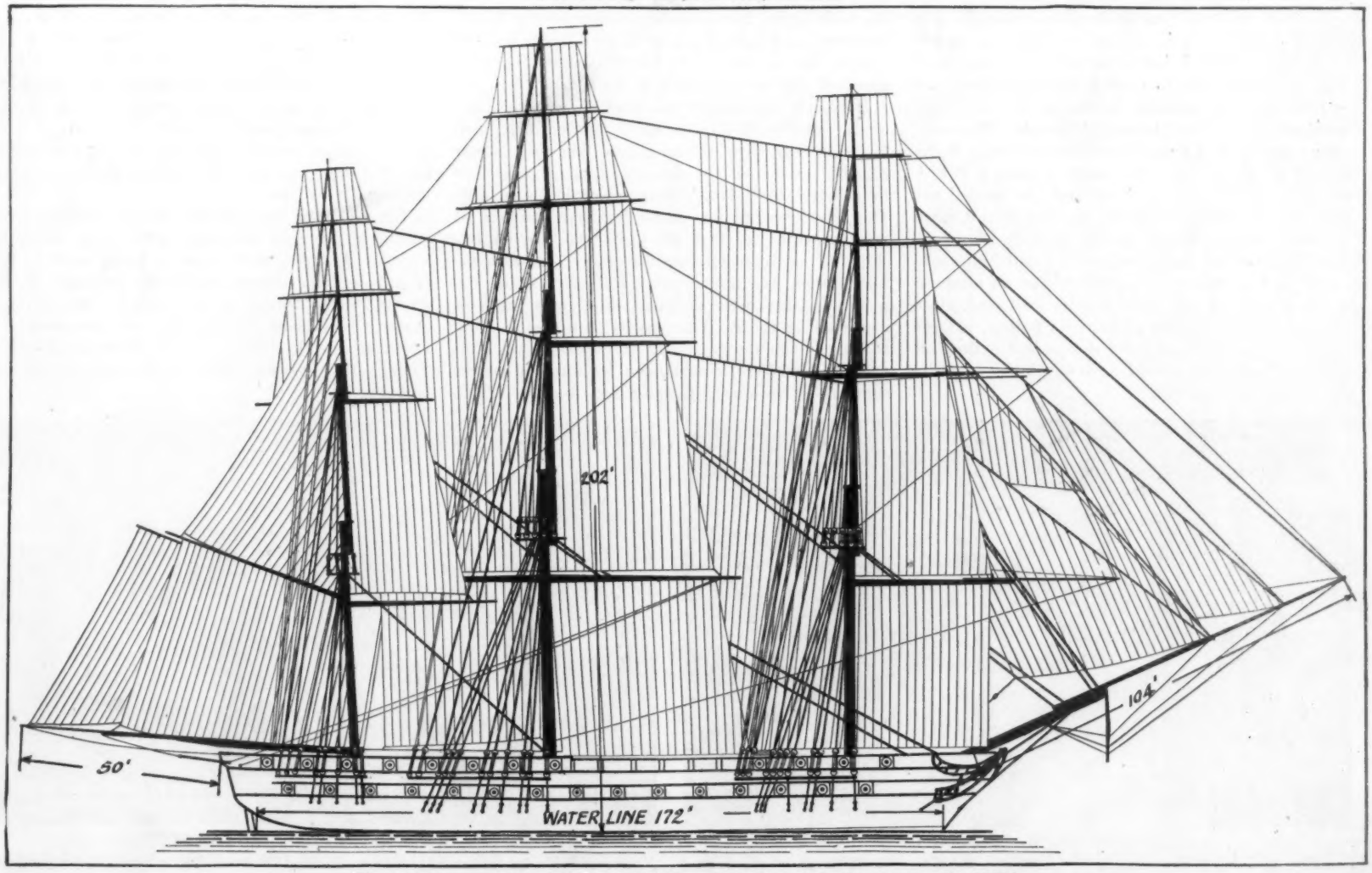
SECTION TAKEN AT MAINMAST

Note how huge sailspread dwarfs the hull



BOWSPRIT AND HEAD RIGGING

To carry the large headsails and hold the towering masts, the head rigging was very heavily stayed. Note the sixty-foot spreader



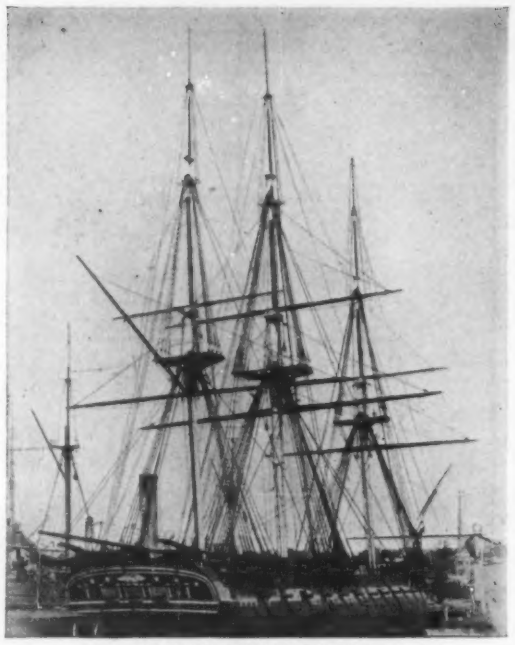
These drawings were traced from the original working plans of the Constitution, *dated 1794*

of her hull. These are tracings of the original plans of 1797, and are perfectly accurate. That her designer, Joshua Humphreys, of Philadelphia, was a naval architect of great talent and daring is shown both by the sweetness of her under-water model and the, to modern eyes, enormous height and length of her sail plan. She was what is generally known as a 44-gun frigate; although she carried more than that, and in the engagement with the *Guerièrre* mounted 54 guns. Judged by the ships which followed her, notably in the clipper period, she was a rather small vessel, her water-line length being only 172 feet, her beam 43 feet 6 inches, and the depth of her hold 14 feet 3 inches. She was built of live oak and red cedar, all well seasoned wood, and the bolts which fastened her timbers were made at the foundry of Paul Revere.

An Ocean Greyhound

But what shall we say of a vessel which, on a water-line of 172 feet, carried a rig whose main truck was 202 feet above the water-line, whose head rigging—bowsprit, jibboom and flying jibboom—reached over 100 feet beyond the stem, and whose spanker boom, with its stunsail boom, extended 50 feet beyond the taffrail! Her mainmast of built-up timbers, heavily hooped together, was nearly three feet in diameter, and her bowsprit but little less. Her rigging was of hemp throughout, and her masting and spars were as large as those of some of the largest clipper ships, built half a century later by Donald MacKay and other famous constructors; for her main yard was 96 feet long, and her skysail yard 24 feet. In fair weather, stunsail booms extending beyond the yards from 30 to 15 feet, added their quota to the vast spread of canvas; and what wind escaped these was caught by the veritable cloud of fore-and-aft staysails between the masts.

To hold this towering rig in place when the ship was jumping into a heavy sea or riding at anchor in a gale, and to balance the sailspread, the head rigging was carried forward beyond anything seen in later days, the spreader located at the end of the bowsprit being 60 feet in over-all length. Of course, such a vast area of canvas could be used only in the lighter winds, as when she escaped from a British squadron on the Jersey coast, and she needed her full crew of 456 men quickly to take in sail when the wind increased and squalls were in the offing. How in the world such a relatively small hull could carry such a vast rig is puzzling; but we must remember that she was very heavily ballasted, since she carried, in addition to her iron ballast, a large supply of powder and solid shot, 4,000 gallons of water and *sufficient provisions to enable her to cruise for a half year on end.*



AS SHE LOOKS TODAY

The famous ship is now in the Boston Navy Yard where she is in danger of sinking at her moorings

Her midship section here shown reveals how sweetly modelled she was. She had round, easy bilges, and the lines of the ship (which we have no space to publish) show that, though she embodied the "codfish head and mackerel tail" form, which prevailed until the yacht *America* showed the advantages of a fine entrance, her bow, though full above, was fairly easy below water, and she had a most beautiful run. Her log shows that, for a time, she made eleven knots, while escaping from a British squadron, and in half a gale of wind under reduced canvas, she is credited in her log with a burst of speed of thirteen and one-half knots.

No doubt Humphreys was familiar with the lines of the fast French frigates which showed their heels to the British ships of that date. Whenever it was possible to do so, the British captured these fast Frenchmen and placed them under her own flag. The *Guerièrre*, as her name implies, was one of these captures, so that the duel was between two ships of approximately the same type, although the *Constitution* was larger, carried a larger crew, and unquestionably was a faster ship, with superior maneuvering ability. The records show that the *Constitution* under the command of Captain Isaac Hull and the *Guerièrre*, commanded by Captain Dacres compare as follows: *Constitution*, tonnage 1,576; *Guerièrre*, 1,338; *Constitution*, 54 guns, *Guerièrre*, 50; *Constitution*, crew 456 men as against 272 carrier by the *Guerièrre*.

We present a diagram showing the approximate courses of the two ships during the fight, extending from five o'clock to 6:30 on August 19, 1812. The favorite maneuver in those days was to cross the enemy's bow or stern and send the whole broadside crashing down the entire length of the enemy's crowded decks. Due to her speed and maneuvering qualities, it will be noticed that the *Constitution*, shown in white, crossed the bow or stern of the *Guerièrre* three times during the fight, and her superior gun fire was so effective that every mast was shot down on the British ship, which lost 79 men, against a loss of fourteen by the *Constitution*. The *Guerièrre* surrendered at 7:00 in the evening. Subsequently, the *Constitution*, in an engagement of five hours' duration, won against the *Java*, a frigate of about the same size as the *Guerièrre;* and later, in an engagement with two smaller ships, the *Cyane* and *Levant*, which mounted between them 55 guns to the *Constitution's* 54, she won a signal victory in about three hours of fighting.

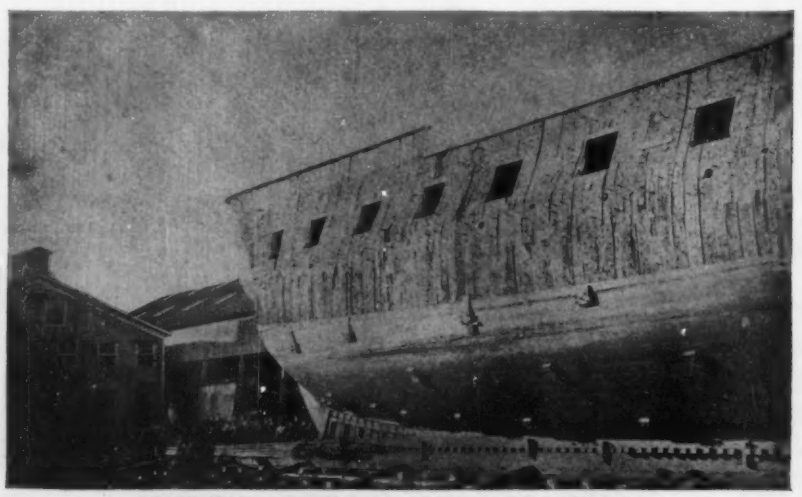
An Appeal to Your Patriotism

Now, the question before the American people is whether a ship, so intimately tied up with the early history of their country and with such a splendid record of fighting service to her credit, is worth the $500,000 which will be needed to rebuild her in the form in which she left the ways in Boston nearly 130 years ago. Are we the same people who, with far less wealth at command, were willing to rebuild the ship in 1833, in 1871, and in 1906? In answering this question, let us remember that *Constitution* is to America what Nelson's *Victory* is to Great Britain. The British, on learning that the *Victory* was in much the same danger as our own *Constitution*, did not hesitate to devote a stone drydock exclusively to the preservation of Nelson's flagship, which will remain in the safe shelter thus provided as long as the British shall see fit to keep her in repair. Shall we, with our vastly larger wealth, and surely with an equally patriotic instinct and reverence for our great naval history, do nothing to save our equally famous ship?

The saving of the *Constitution* has thus become a matter of personal conscience with every American citizen. A widespread appeal is being made to the schools of the country, under the auspices of the United States Daughters of 1812 of the various States. Individual citizens who are interested are asked to send their checks to "Save the Constitution Fund," Charlestown Navy Yard, Boston, Massachusetts.

LOOKING ALONG THE GUN DECK

The ship carried fifty-four guns in her fight with the Guerièrre, thirty of which, firing a 24-pound solid shot, were on the gun deck



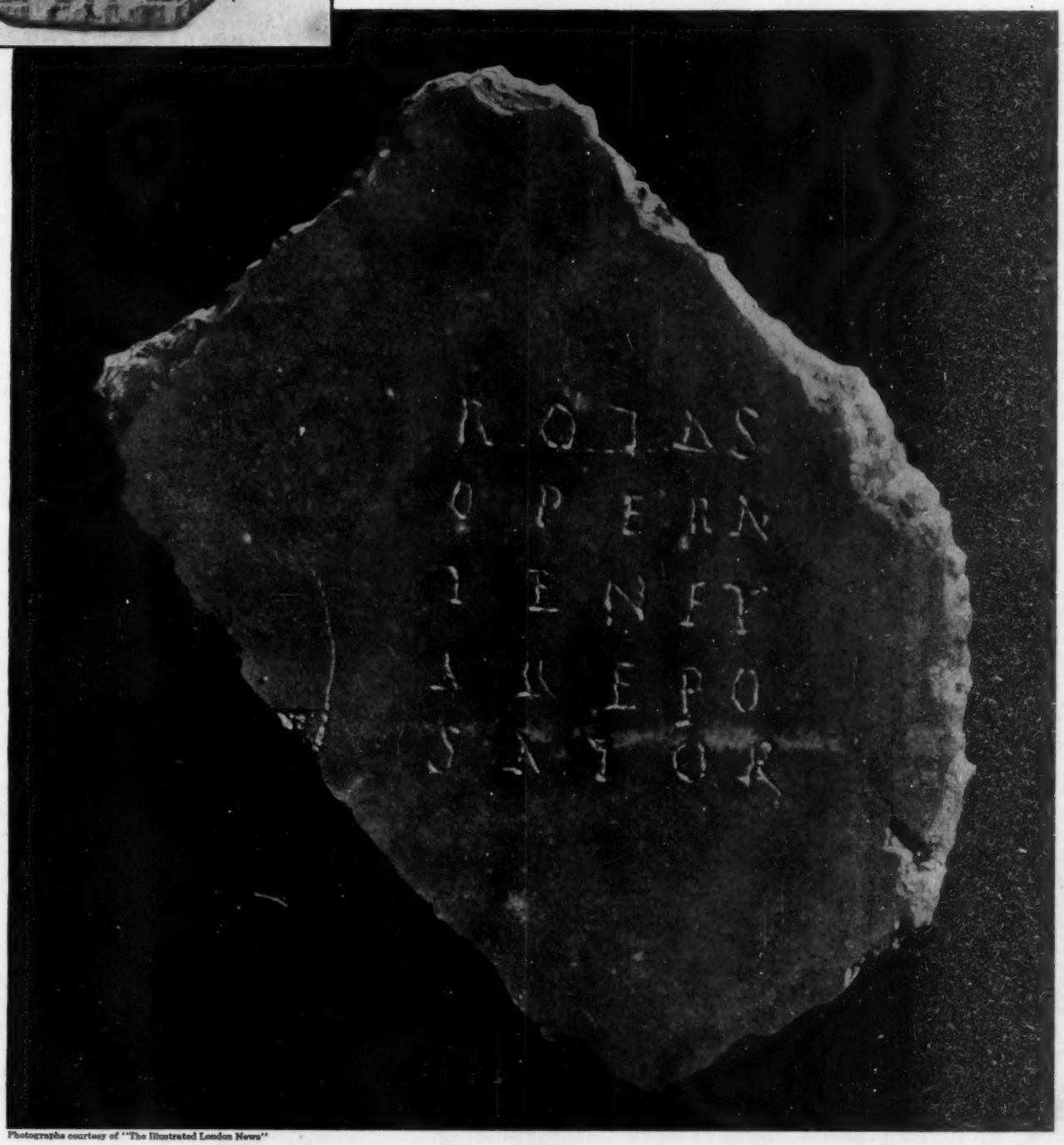
THE FIRST REBUILDING OF THE CONSTITUTION

Hauling the ship out for her first reconstruction in 1833 at the Boston yard. Upper planking removed, showing the framing, closely packed to keep out shots

Latin "Cross Words" on oak in Great Gidding Church, near Peterboro. The letter "E" should be substituted for the "I" in the words "Aripo" and "Tenit"

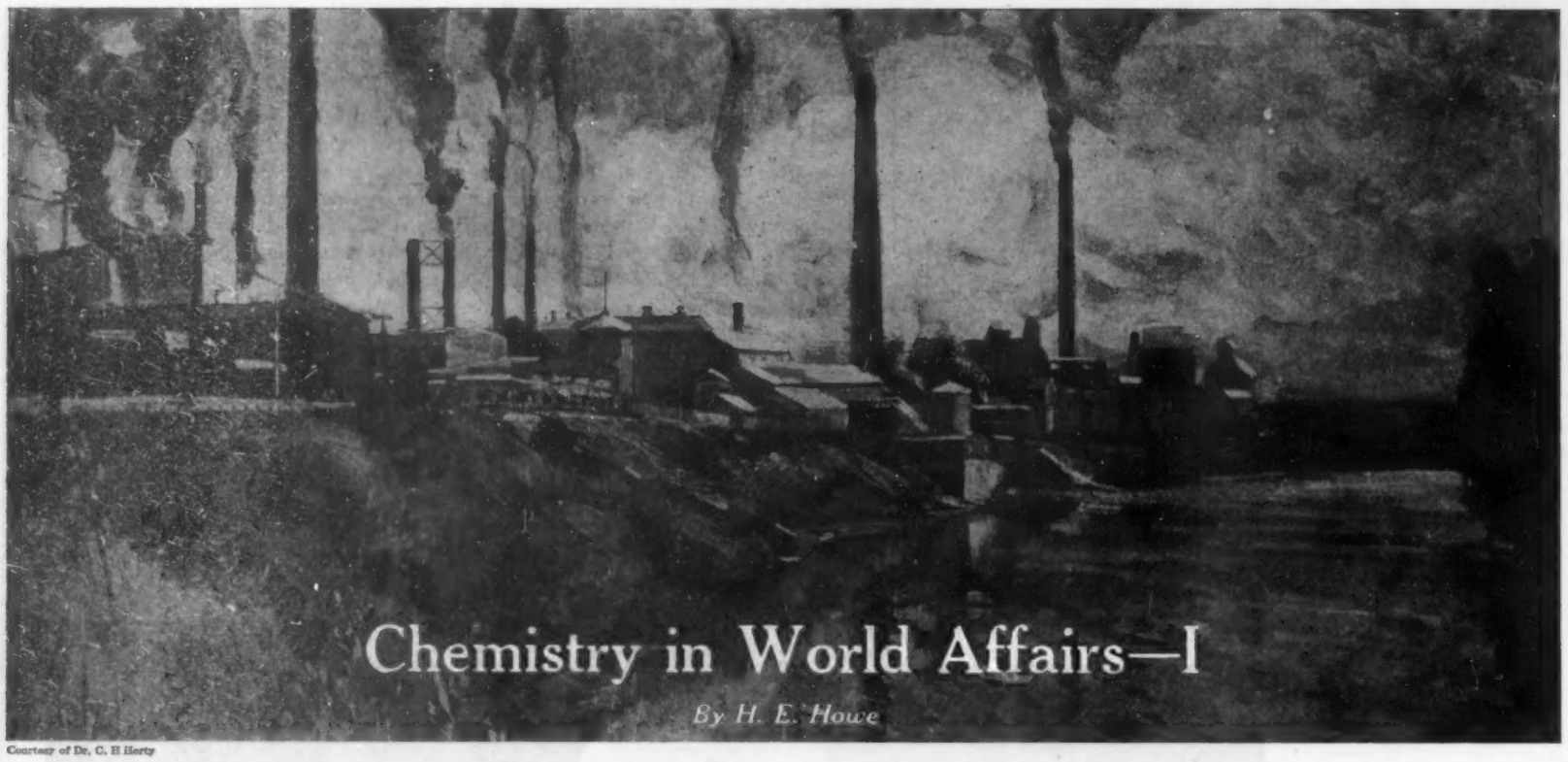
"Cross-Words" *Anno Domini* 225

THE craze for cross-word puzzles seems to have been in vogue as far back as 1700 years ago, in the days when the early Romans were in occupation of Britain. Our authority for such an assumption is a fragment of painted wall plaster now on exhibition in the Corinium Museum, the property of Earl Bathurst, at Cirencester. The "Guide" to the Museum states that this fragment was found during excavations at Cirencester in 1868. It is an indisputably genuine relic of Roman times. The words scratched through the surface color of the plaster read: "Rotas opera tenet Arepo sator" in four directions, and "Sator Arepo tenet opera rotas" in four other directions. It has been interpreted as meaning, "Arepo, the sower, guides the wheels at work." The same curious inscription appears all over Europe, and not infrequently in the East. A Seventeenth Century copy of the same word-square appears on an octagonal piece of oak in the church of Great Gidding. It is thought that the E. R. may be the initials of the Vicar in 1614—Edward Rumbolt, and the words may allude to his manner of conducting the service: "Sat orare poten? et opera rotas." "Are you able to pray sufficiently? and you gabble through the Church services."



Discovered in 1868 during excavations on the site of the ancient Roman town of Corinium (modern Cirencester). The words are printed in Roman "Rustic Capitals," of the type found in inscriptions at Pompeii and disused after the Ninth Century

Photographs courtesy of "The Illustrated London News"



Chemistry in World Affairs—I

By H. E. Howe

Courtesy of Dr. C. H Herty

FOR the most part international relations grow out of efforts to improve the status of a country either as regards the physical or the financial well-being of the people. These two considerations are basic, although they are to be found in many forms all along the path of history. The enforced territorial expansion of a country, while primarily to permit peoples to go out from centers of great concentration of population, in the end means that a greater quantity of natural resources must be found.

Only in comparatively recent times has the physical well-being of a people become a prime consideration. Assistance in overcoming a plague or an epidemic, relief in times of famine, and the defense of weaker peoples against oppression have become more common phases of international relations since the days of republics. Indeed, republics themselves are the result of the effort to further the interests of the people as a whole as opposed to a ruling class.

The control of natural resources which are desirable in peace and vital in war may be said after all to be the basis of most international dealings. A nation seeking power in commerce or an impregnable position in war directs attention to natural resources of present value and future application.

Emperor Was on a Hunting Trip

Natural resources and their development always involve chemistry, since chemistry is the science which concerns itself with the characteristics and properties of materials under all varieties of conditions. The resources themselves may be expressed in terms of chemical compounds and before they can be economically utilized, chemical research and technology is invariably called in.

That nation, therefore, which pays the greatest attention to the development of chemistry and its application to the arts may well be said to occupy a commanding position in international affairs. A knowledge of substances and how best to use them for given purposes may be even more important than the ownership of the resources themselves. To prove this may be cited the refining of tungsten from its ores and the separation of radium from carnotite. In both these instances countries without the raw materials gained a commanding position through research and development, so that ores were sent to them to be refined instead of the knowledge of how this was done being transmitted to the sources of supply. Let us examine history and see what examples of international relations to which chemistry has been the key may be found to support this premise and to show how the advantage has shifted, now to this nation and now to that, depending upon scientific work and principally work in chemistry.

One of the earliest severe strains upon international relations came about through the loss by storm at sea of three cargoes of those chemical substances known as spices and perfumes. A world-wide panic ensued, and while, to be sure, it was a financial panic, it must not be forgotten that finance is after all closely related to and at times dependent upon chemical development. In this instance a bank at Athens had loaned great sums to those engaged in the importation of these small cargoes.

Then, as today, banking was conducted cooperatively by the banks all over the known world. The total loss represented by the sinking of the ships made it necessary for the bank at Athens to call upon its correspondents and they in turn upon their correspondents, until Rome itself felt the pressure. It so happened that at this time a decree by the Roman emperor had directed the financiers of the day to invest a certain large percentage of their funds in agricultural development and much money had been withdrawn from the banks for this purpose. It was not a simple matter to have this money immediately deposited again, and the emperor was off on a hunting trip. Things became very acute before the end of the ten days necessary to secure his return, and only when the edict was rescinded and much of the emperor's wealth made available, did the financial world get on its feet again.

Courtesy of the General Electric Co.

AN IMPORTANT ELEMENT OF ELECTRIC LAMPS

Swaging tungsten anodes for Coolidge tubes

Ancient Conquerors Were Engineers

The wealth and power of those ancient cities, Carthage and Tyre, which were comparable to at least the smaller countries of our day, were based upon a chemical compound found in minute quantities in the dorsal vein of a snail-like shellfish called *murex*. In modern times great piles of these shells have been found near the sites of these ancient cities, and one may easily imagine the hazards involved in collecting a quantity of such fish, from each of which no more than a few drops of a mucilaginous fluid could be obtained. When this fluid was put upon fabric or leather and exposed to air and sunlight the famous Tyrean purple was formed. In fastness to light and washing, in brilliancy and uniformity, its color did not compare with the indigoes and dibrom indigoes of American dye makers today.

Feats of old, like the use of Greek fire and numerous devices employed in the defense of Constantinople, gave temporary advantages to those who had this special knowledge. The conquerors of old employed engineering at every turn, and those who developed the blades of Toledo and Damascus by processes now known to have been chemical, although not so recognized then, had an advantage over adversaries comparable with that gained by the first man who found out how to make metal into a weapon for use against the wooden clubs of his adversary.

To this day people believe that the art of hardening copper has been lost forever, and scarcely a week goes by without some clever man's offering to sell to our great metal concerns the secret which he has rediscovered. Science has not answered all the questions of the ages, but the scientific method has nearly always been able to find causes, break problems into component parts, and solve them so that conditions for production may be satisfactorily duplicated.

The balance of power was at once disturbed when the chemical compound gunpowder was invented. It was a means of utilizing the energy of chemical separation and became a new factor in international relations.

A fundamental material in the manufacture of all explosives is nitric acid, and a source of nitrates became the thing greatly to be desired. From the time of the invention of gunpowder until the middle of the Nineteenth Century, Indian saltpeter was the only known available source of the element nitrogen, in a form which could be used for nitric acid.

These Indian resources were in the form of potassium nitrate which had been deposited in the soil or rocks, through the action of nitrifying bacteria. But nitrification requires for optimum conditions a supply of nitrogenous organic matter, a given range of temperature, a limited amount of moisture, and the presence of a small amount of alkali, oxygen or air, and of the nitrifying bacteria which require complete or semi-darkness for their work.

When potassium salts are present, potassium nitrate is produced, but the native niter usually consists of calcium nitrate and some magnesium nitrate. Where there is no excess of rain, the soil moisture brings the solution of these soluble nitrates to the surface where they are deposited as an efflorescence as the water evaporates. Obviously the amount of niter procurable from natural deposits and formed under natural conditions is very limited and as the demand for saltpeter increased, other sources of supply were sought.

Nitrates Enough for 300 Years

Following the principles that had been observed in the formation of natural deposits, nitrate plantations were established in many countries where nitrates were slowly formed and protected from the weather. The plantations of Hungary, Switzerland, France, and Sweden have been described in detail in literature. Resort to the same methods was had by the Confederacy during the Civil War. In emergencies, as in Sweden in 1520, even the earth of cemeteries was lixiviated to obtain niter, and at one time Sweden imposed a tax which had to be paid not in money but in saltpeter.

About 1821 the immense deposits of sodium nitrate in South America were discovered, and the importance of these beds need not be stressed here. The deposit extends for some 450 miles north and south in the arid plains between the Andes Mountains and the coastal range on the Pacific, at distances of from fifteen to ninety-three miles from the sea, and at altitudes of from 3,600 to 13,000 feet. The exploitation of this deposit has proceeded rapidly and has become a source of revenue to the Chilean Government.

Some years ago the exhaustion of the Chilean nitrate was forecast, and when Sir William Crookes predicted the possible starvation of the earth, he pointed out that the yield of wheat could be increased from an average of 12.7 bushels per acre to 20 bushels or more by the use of 150 pounds of nitrate of soda on each acre annually.

It now appears that these estimates were based upon the then known deposits which were only a fraction of the actual deposits in Chile. In addition to this, there have been perfected processes for recovering nitrates from low grade ores that had not previously been worked. It is now estimated that at a rate of consumption of five million tons annually, the Chilean nitrate should last some three hundred years.

However, Chile is at a considerable distance from many nations which have found nitrate an essential in their world programs. Lines of supply in war time always present a difficult problem, and if such an essential material must always be brought overseas, the problem becomes further complicated. While great navies have been maintained for the protection of merchant shipping and of nationalists at great distances from home, the nitrate situation has doubtless played a commanding part in the formation of an extended naval program. It, therefore, became a scientific problem of world importance, how to make available the tremendous quantity of nitrogen present in the atmosphere.

It has been estimated that the air over each acre of earth contains 33,880 tons of nitrogen, but to all intents and purposes this nitrogen is inert, since plants and animals can utilize it only when formed into nitrogen compounds.

For many years experiments have been conducted in an effort to find a way to fix this nitrogen. The early researches were of a purely scientific nature. Priestley more than a hundred years ago found that by passing an electric spark through an atmosphere of nitrogen he could obtain traces of the oxides of nitrogen. Without giving all the historical details, it may be pointed out that, following commercial experiments in America, the cheap water power of Norway enabled that nation to obtain something of an advantage when it was found that the nitrogen of the air could be oxidized by great electric arcs and recovered as nitric acid, although usually sold as calcium nitrate. The efficiency of the process was low, but hydro-electric power was extremely cheap and the advantages gained were well worth the energy expended.

Nations of Europe with military tendencies at once became interested in Norway and took pains to acquire large financial interests in the Norwegian companies. Other scientists took up experiments in this field in the hope that they might find still more efficient methods. Great plants for the fixation of nitrogen by the cyanamide method sprang up in Norway and on other parts of the continent and became important factors in international relations.

Nitrates Are Essential to Food Production

It was only a little more than ten years ago, when the Eighth International Congress of Applied Chemistry met in the United States, that we were given our first information of the success of experiments carried on by Haber at the expense of the *Badische Anilin und Soda Fabrik*. It was demonstrated that under certain secret conditions nitrogen and hydrogen could be caused to unite to form ammonia. This synthesis was carried on in the presence of a catalyst, a catalyst being a substance which promotes a chemical reaction without suffering self-change or entering into the final product.

The early methods for the fixation of nitrogen required great blocks of electric power, but today we find conditions changed. Much less power will answer. It is true that the Haber process is operated at a pressure of 100 atmospheres and a high temperature. However, the recent work of Claude in France indicates that at still greater pressures, indeed up to 1,000 atmospheres (15,000 pounds) per square inch, the fixation is more rapid and the yield greater, the deterioration of the catalyst is retarded, and apparently the net gain is considerable.

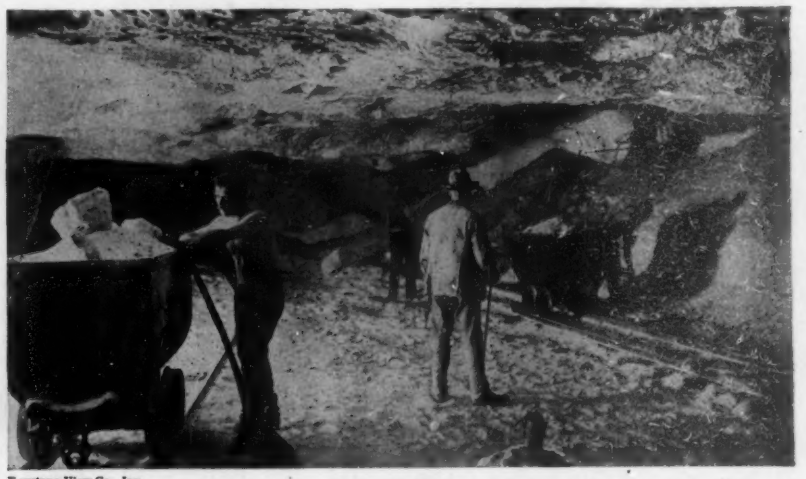
There are several industries where hydrogen is a waste product and where it is purer than that prepared solely for the fixation of nitrogen by the synthesis of ammonia. Such power as is required need not be electrical. In a Haber type plant nearly seventy percent of the operating cost is charged to the purification of gases. Obviously if atmospheric nitrogen fixation can be carried on in small units located where relatively pure hydrogen is available as a waste product, we shall have taken a great step forward in the nitrogen problem.

We must not overlook the fact that in international relations the food supply is vital. Nitrates are essential in food production, and while it is doubtful whether under present conditions nitrogen from the air can be fixed at a price to compete with Chilean nitrate, it is well to remember that in times of war when costs are not considered, fixed nitrogen plants might be the salvation of a nation.

Courtesy of the Trona Corporation

A SOURCE OF POTASH

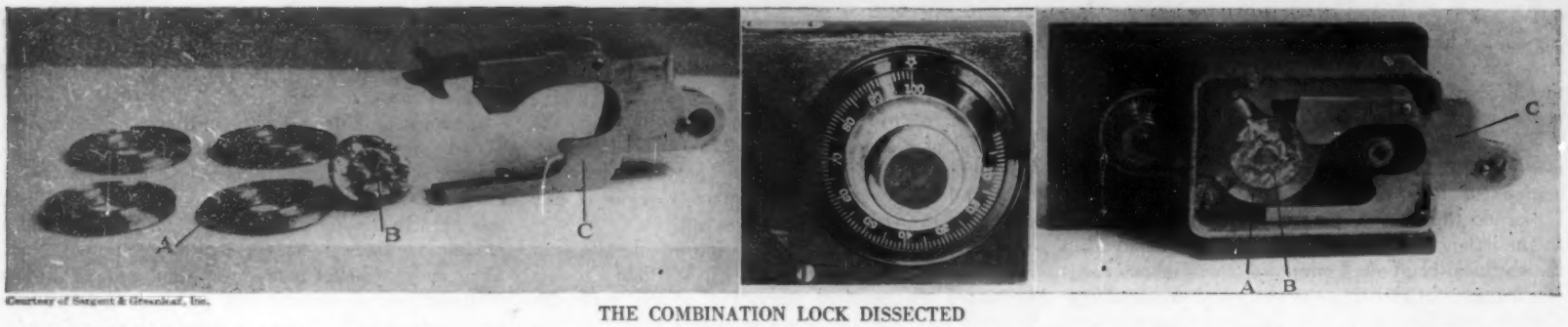
Searles Lake, California, showing the pipe line for drawing off the brine



Keystone View Co., Inc.

WORKING AT A TEMPERATURE OF 104 DEGREES

In the heart of a potash mine in Stassfurt, Germany, 2,600 feet underground



Courtesy of Sargent & Greenleaf, Inc.

THE COMBINATION LOCK DISSECTED

At the left will be seen the combination lock dissected, this shows its simplicity. The tumblers are shown at A, the cam at B, and at C, the bolt mechanism. In the center is shown a dial with a hundred numbers which gives combinations of a hundred million. In the right-hand illustration is shown the lock assembled with the driving mechanism.

There Are No "Jimmy Valentines"

The Burglar Doesn't Live Whose Sense of Touch Can Find the Combination of the Modern Vault

By E. J. Goodnough

A FEW months ago the writer, a lock expert for a leading safe company, was en route to a town in Tennessee where a bank had reported that the combination lock on the vault door had refused to work. In the train he sat beside a man who was deeply interested in the morning paper. Suddenly the stranger turned and said:

"Of all bunk! This article tells about a safe being blown and the yeggs getting away with $1,200."

"What I can't figure out," he went on, "is why the fellows who do this sort of thing don't use their heads a little more. If they would spend their time studying combination locks they would soon learn to open them without disturbing the combinations or the doors and running the risk of injury or arrest because of the racket."

From the description in the paper, the combination lock of the vault clearly was of a high grade. I told my new acquaintance I often had heard of experts who could open any combination lock by the sense of touch and the sense of hearing, but I never had been fortunate enough to meet anyone who could tell me just how it was done.

"Well," said the man beside me, "it takes a lot of time and study, and above all, patience. I can do it myself about eight times out of ten. It's all the result of cultivating a keen sense of touch so as to feel the slots in the tumblers as they come in contact with the unlocking device. In other cases you can hear the tumblers as they fall."

After he had related several of his experiences in opening safe and vault doors of the burglar-proof type I asked him what his business was.

"Oh, I'm with a burglar alarm company," he replied.

I asked him for the names of some of the banks whose vaults he had opened and he mentioned one that I happened to be familiar with. Its door is ten inches thick of solid steel and is equipped with the latest time-lock and burglar-proof combinations.

Sandpapered Fingers of No Use

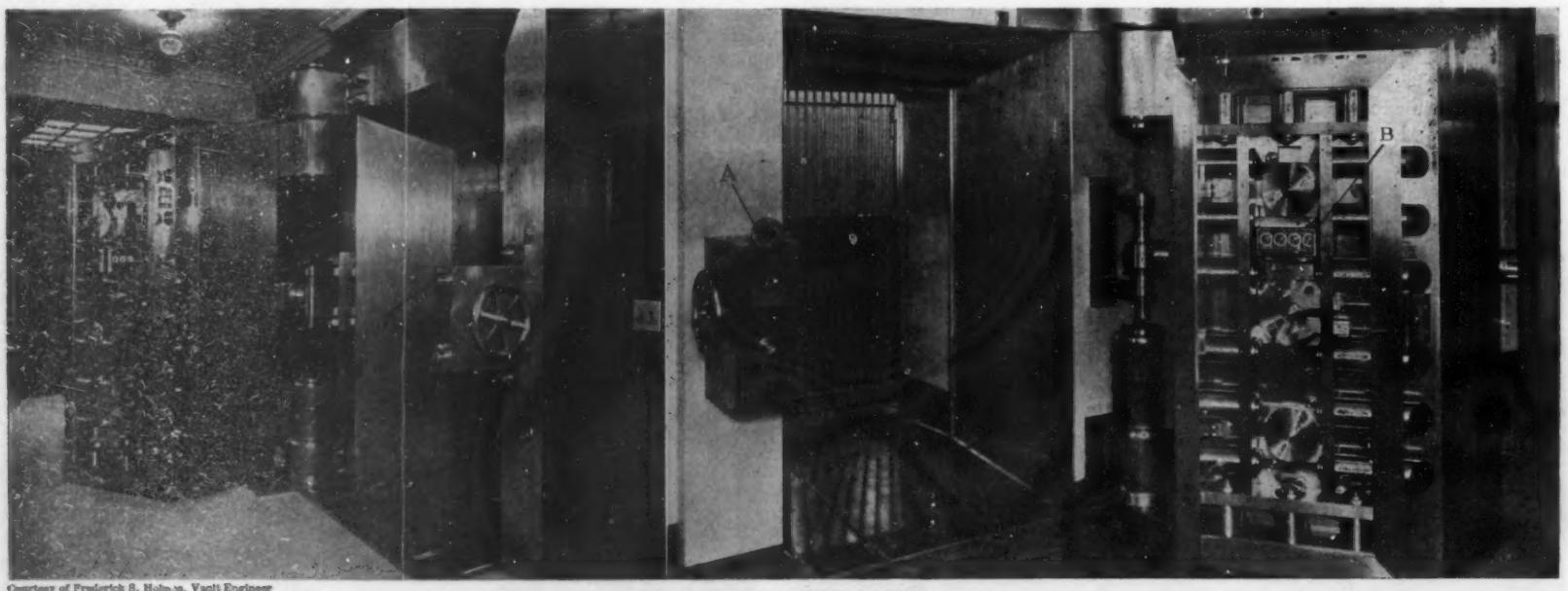
"I've spent my life in the safe business," I said, "and I know what you claim to be able to do is impossible. I'm now on my way to a bank where the combination lock refused to work. If you will go with me I will pay you one hundred dollars if you open the locks without disturbing the doors."

He squirmed about a bit and then finally admitted, "I guess you've got me. I've talked this sort of thing so much in my business that I've begun to believe it myself."

With the men who write detective stories and men interested in promoting certain lines of business, both hammering away at the integrity of the highest grade combination locks, it is not hard to explain why the general public and even some bankers have an exaggerated idea of the capabilities of crooks. It is true there are cheap types of locks on some fire-proof safes that may be opened by the sense of touch, but I feel entirely safe in saying that there never has been a high-grade lock so opened, provided it was mechanically correct.

Not long ago a magazine article was published telling how a burglar might obtain the combination if he could inspect the vault door while it was open. The method was to turn the bolt handle into a locked condition and then feel the impulse on the dial knob when the tumblers were touched, each number of the dial being noted.

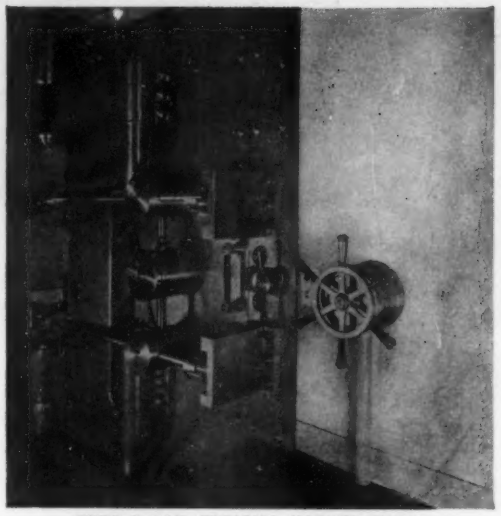
Only in a few combination locks is this possible. The burglar's success depends almost entirely upon the amount of friction in the tumblers. Two other factors also tend to make his success practically impossible. First, some bankers after opening the vault turn the bolt handle and the combination into a locked condition, locking the door open in order to prevent their being locked in the vault in the event of a daylight robbery. This, of course, places the door in the same locked condition as if it were closed and the bolts in the proper places in the door jamb. In the case of modern locks it is not pos-



Courtesy of Frederick S. Holman, Vault Engineer

SOME HUSKY VAULT DOORS

In the modern vault, the combination locks are often put on the door jambs instead of on the door, so that their strength is not impaired. Such combination locks are shown at A in the left-hand illustration. In the right-hand illustration at A is shown a new illuminated dial which is common to the three locks. This dial is so arranged that it is only visible to the person opening the lock. At B is shown a four-dial time lock. Should the door be dynamited the lock will collapse. The vault would then have to be entered by the wall.



THIS DOOR WEIGHS FORTY TONS

Note the massive hinges and pressure mechanism. The wheel operates the movable platform

sible to get any "feel" that would indicate the combination. In the second place, a stranger is never admitted behind the fixtures of a bank without the best of credentials.

Again and again on the screen or stage we have seen a burglar put his ear to the lock, give a few turns and then swing open the door. To the layman this is known as hearing the tumblers drop. The fact is, however, that the tumblers are round and turn on a bearing, being driven by a cam which is fastened on a spindle, which is actuated by the dial through gear mechanism.

To my knowledge there never was a combination in which the tumblers dropped. The only device that drops is a lever which bears on the diameter of the driver. There usually are four tumblers, larger in diameter than the driver, and the lever does not touch the slots while the combination is being worked. This automatically disposes of the sense of touch theory.

Not long ago we received a telegram from a bank in Iowa reading: "Man who opens our combination lock injured, not expected to live, doors locked, send expert at once."

Our records showed that the cashier, when the vault was installed, desired to change the combination, himself, so that it would be confidential. This, of course, left me with nothing to work upon. When I arrived at the bank there was a crowd gathered to see me open the door. The president could tell me nothing and the cashier was unconscious. When I told the president that the only way I could open the door without knowing the combination was to go through the walls of the vault, he said:

"I am afraid you have your company's burglar-proof guarantee in mind. I am willing to forget about that if you will open the door at once."

To my insistence that such a procedure was impossible, his only reply was to offer me a substantial personal reward if I would open the door immediately. When I saw it was impossible to convince him I went to the door to try a few combinations. I turned the dial several times to the right trying to decide which numbers to use.

While I was thinking about it I turned the dial back in the contrary direction and the lever fell into the tumblers and the lock opened.

I was the only surprised person in the crowd, for everyone else had been certain I would do just what they had seen me do. I opened the door, took the tumblers out of the lock and found they were all set on one number. By sheer luck I had stopped on the number when turning the dial. It took me one hour to convince the president that it was sheer luck and nothing else.

With the modern burglar-proof lock, each of the four tumblers has one hundred numbers. This type of lock can be set on one hundred million different combinations. The explanation is simple. If we had but one tumbler in a lock we would have 100 combinations. With two, we multiply 100 by 100 and have 10,000. When we add the third tumbler with its 100 numbers we multiply 10,000 by 100 to get 1,000,000. The fourth tumbler gives us 100 times 1,000,000, or 100 million.

Has it ever occurred to you that a combination lock could be opened by trying all the different combinations it might be set on? But think how long it would take to try all the different combinations. If you were to work an entire combination every minute for twenty-four hours, you would work only 1,440. In one year you would have worked out only 525,600. In about 190 years you would have worked all the possible combinations, provided you didn't stop for a single minute. That gives you some idea of the possibility of finding the correct numbers.

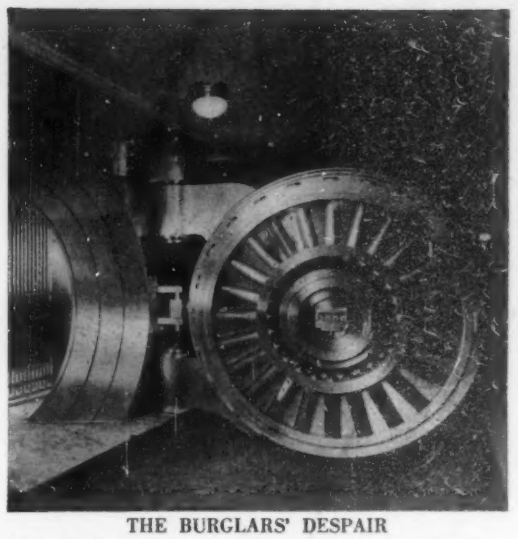
Combinations Cannot Be Solved

To drive the lock spindle through a burglar-proof vault door is an impossibility, for the spindle that runs from the dial to the lock on the inside is so made that driving on it merely serves to jam or bend it into such a condition that it cannot be removed. Even if you were successful in driving this spindle through the door you would have removed only the first drive gear that drives the second gear. It then would be impossible to open the lock.

The modern vault is absolutely air-tight. To be locked in one may mean almost certain death. Various devices for safeguarding "locked-ins" have been provided, such as oxygen tanks, breathing holes, and so on.

Many people believe that time locks secure the doors at a given hour each day and also open them at a fixed hour. This is true only of a few old types of locks which now are almost extinct. The latest time locks are wound to the desired number of hours every time the door is to be opened and if the lock is mechanically correct it cannot be opened until that time has elapsed.

There are time locks that can be kept locked for an indefinite period by means of an electrical arrangement operated by remote control. This is of advantage in the event of a riot, fire, flood or other emergency. It merely stops the movements of the time lock. When the device is released the movements start and in about one hour the lock opens.



THE BURGLARS' DESPAIR

Circular doors sealing a safe are especially so when protected with all the vault engineers' safeguards

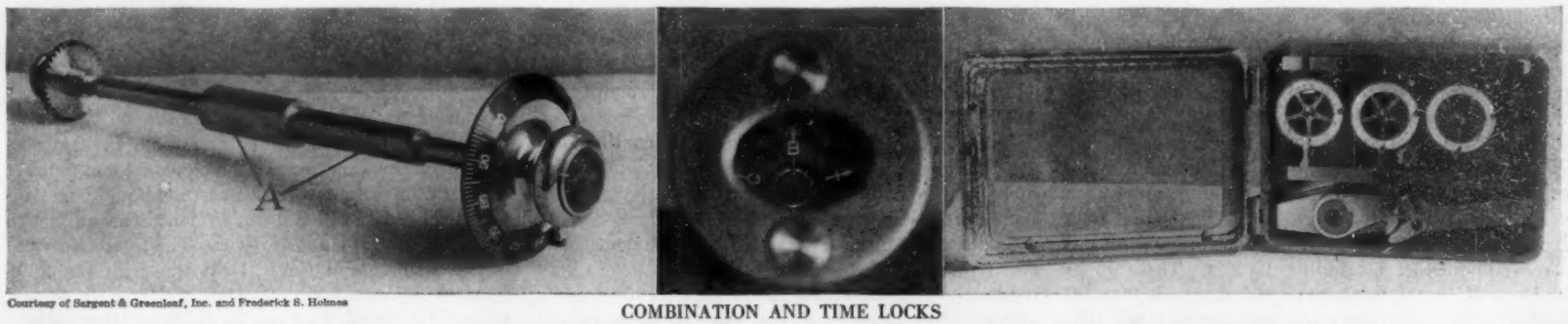
The highest grade of time locks are entirely automatic. They have no connection with the outside of the door. Explosions or terrific pounding on the door have little or no effect on them, as in some cases they may rest on springs or rubber pads which absorb the shock in the same manner that the shock absorber takes up the jars in your automobile. A dynamite plate at the rear casing of some time locks serves to lock the bolt mechanism if the force of the explosion is close enough to the time lock.

About two years ago I changed the combination on the safe in a large department store in a town in Ohio, giving the auditor a copy of the combination. A year later the safe was mysteriously opened and a large sum of money taken. Detectives had a number of theories as to how the burglary had been committed and the chief of the sleuths declared that the matter would be cleared up in a few days, as he knew three members of the town's underworld who could have opened the safe.

The manager of the store assured me that no one but himself and the auditor had ever known the combination. He assured me he had locked the safe before leaving on the night of fthe robbery.

The detectives were certain that some safe expert had done the job. It later developed, however, that the auditor had deposited four hundred dollars in a suburban bank and five hundred in a downtown bank the day following the robbery. He later confessed that he had taken the money, believing that it would appear that yeggs had solved the combination.

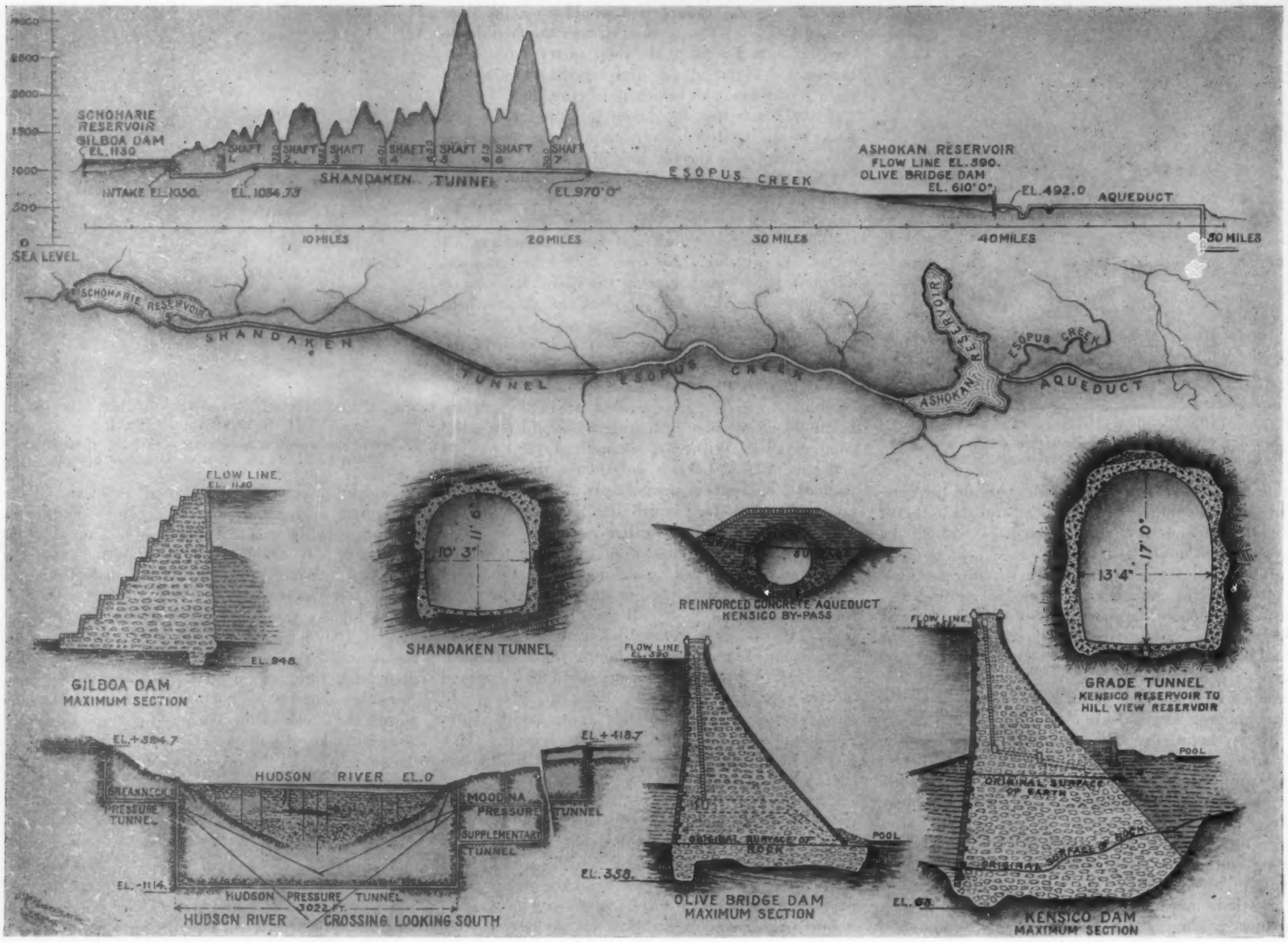
But it wouldn't work. Yeggmen can not solve combinations, no matter how sensitive their fingers or how acute their hearing. Nor can anyone else.



Courtesy of Sargent & Greenleaf, Inc. and Frederick S. Holmes

COMBINATION AND TIME LOCKS

At the left is shown the dial, the spindle and the gear wheel which engages the driving mechanism for the tumblers. The shoulders on the spindle prevent the spindle itself being driven through the vault. The center illustration shows the illuminated dial common to two or three locks as shown in position on the preceding page.. At the right is a three-dial time lock. Any one of the three locks can trip the small bolt and allow the great bolts of the vaults to function. Behind is a "dynamite plate" insuring collapse to save contents.



World's Greatest City Water Supply System

IT is not stretching the point too far to say that the provision of an ample, pure and permanent supply of water is the most essential requirement for the health and comfort of a great metropolitan city. A conflagration or a sweeping epidemic may be controlled; but a water famine would be absolutely destructive to the inhabitants. Hence, some of the greatest engineering skill of both ancient and modern days has been shown in the provision of adequate schemes of water supply. Ancient Rome daily received 400,000,000 gallons of water for household purposes, and to supply its innumerable fountains and vast bathing establishments, and all of this water had to be carried across the Campagna in fourteen stone or brick aqueducts, whose ruins, stretching for forty miles or more across the plain, are one of the wonders of the archaeological world.

The first notable work for the water supply of New York City was built in the middle of the last century when the old Croton dam and aqueduct were constructed. Some forty years later this supply was increased by building the renowned Croton Dam and a second aqueduct paralleling the first. These works had a maximum usable capacity of about 336,000,000 gallons a day, and seemed at the time to make adequate provision for the future. So rapid, however, was the growth of the city that more than once it was threatened with a water famine, and the authorities realized that an additional supply of fresh drinking water must be made available.

Tunnel Eighteen Miles Long

A special board of engineers decided to take the bold step of tapping the waters of the Catskill region. The plan was to build a large dam across Esopus Creek and impound the waters that fell in the watershed of that stream. The Olive Bridge dam, whose cross-section is shown above, is a masonry structure, 210 feet from foundation to crest, which impounds a total of 128,000,000,000 of gallons, sufficient to cover all of Manhattan Island with water to a depth of thirty feet. It now looked as though the water supply of New York City was secure for an indefinite period; for the completion of Ashokan added an additional safe supply of 250,000,000 gallons.

But the population of New York City continued to grow at an increasing rate and the city authorities early awoke to the fact that further and vast additional provision must be made, if the danger of an ultimate water famine was to be eliminated. And now it was that the engineers decided to take a very bold step. An additional water supply of adequate amount was located on the opposite side of the mountain range of the Catskills, where the Schoharie Creek, heading on the northern slopes of the Catskills, flows down into the Mohawk Valley. So a masonry and earth dam was built across the Schoharie and a reservoir with a capacity of 20,000,000,000 gallons was formed. It was decided to drive an eighteen-mile tunnel, the longest of its kind in the world, through the mountain range, and by this means discharge the water from the Schoharie reservoir into the higher reaches of Esopus Creek on the southerly flank of the Catskill range. For twelve miles these waters pass down the natural bed of the stream and discharge into the Ashokan reservoir. The Schoharie scheme insures that the rain which falls on this combined drainage area of 571 square miles, finds its way for from 90 to 156 miles by way of the Kensico emergency reservoir, and the Hill View reservoir near Yonkers, to New York City, where the inhabitants can draw off this pure mountain water by the turn of a faucet.

Our drawing shows several of the most notable portions of this vast work, and these include sections of various portions of the aqueduct and notably a longitudinal section of the vast syphon 12 feet internal diameter, which drops over a thousand feet to pass beneath the Hudson River. The total safe yield of the Croton and Catskill system, with the 200,000,000 gallons from artesian wells, and so on, brings the grand total up to 1,036,000,000 gallons per day. This great yield makes the city safe, however, only until 1935.

Mount Wilson Observatory, Pasadena, California

Three Newly Discovered Comets

By Henry Norris Russell, Ph.D.

IN articles such as this, which must from the necessities of the case, be prepared some two months before they are published, it is impossible to be up to the moment with reference to such rapidly moving objects as comets; but, though delay is unavoidable, the discovery of three comets within two weeks cannot be passed over.

The first discovery was made on March 24th by Mr. Schain, of the staff of the Pulkovo Observatory in Russia—a welcome instance of the revival of scientific activity in that country—the second on March 26th, by Mr. Reid, an amateur in South Africa, and the third on April 4th, by Mr. Orkisz, at Cracow in Poland. All three are under observation, and preliminary orbits have been computed.

Schain's comet, though but a faint object of the eleventh magnitude, turns out to be of unusual interest on account of its great distance.

Three preliminary orbits, calculated from the earliest observations, have appeared. Computation at the University of California make the perihelion distance 4.14 times the earth's distance from the sun, an English computation 3.96, and a German calculation, 3.45. The determination of an orbit from observations but a day or two apart is much like trying to find the size of a large circle from three points close together. The slightest error in the position of the middle point will be enormously magnified when it comes to calculating the size of the whole circle. The discrepancies of the various results are therefore not alarming. A few weeks more of observation will show which is nearest right.

But the important fact is that all agree in concluding that the comet can never come within three hundred million miles of the sun, and perhaps not within four hundred million miles. Only one other comet out of the hundreds which have been seen has a track lying so far out in space, and this was one observed in 1729. Most comets, for example the far-famed Halley's comet, when at this great distance from the sun, are barely visible, even if calculations tell the observer just where to look. We would stand no chance at all of accidental discovery. The present object, therefore, must be, in reality, a great comet. But since it will never come near the sun there is no hope of its making a great show. The three computers agree that it will not be nearest the sun till the end of the present year.

Reid's comet, according to computations made at California, has an elliptic orbit with a period of between fifty and a hundred years. It is close to perihelion at present and will doubtless be under observation long enough to get a good value for the period, although, as it is going south in the sky, we shall have to depend on observers in the southern hemisphere.

Orkisz's comet, from a first preliminary orbit, appears to have a perihelion distance of a little over one hundred million miles and an orbit almost at right angles to the plane of the ecliptic. It had just passed perihelion when discovered and will be accessible to northern observers for some time.

Recent Discoveries Among the Stars

.Two recent discoveries among the stars may well fill out this record of current events. Professor Shapley, at Harvard, continuing his work on the Magellanic Clouds, has concluded that an irregularly variable star of the ninth magnitude, S Doradus, belongs to the Cloud and shares its great distance of 110,000 light years. This makes the star, on the average, 600,000 times as bright as the sun and by far the most luminous object yet known.

The star itself is evidently a very hot one, with bright lines in its spectrum, resembling the well-known star P Cygni. Several other stars with spectra of this sort appear in the Magellanic Cloud and are exceedingly luminous objects ranging from 15,000 to 60,000 times the sun's brightness; but this one excels them all. Even with a liberal allowance for the great brightness of so hot a surface, which may be fifty or a hundred times that of the sun, its real diameter comes out seventy or eighty million miles.

A second discovery of notable interest has just been announced by Mr. Pease, of Mount Wilson. His observing test with the interferometer—with which he made the two recent measures of the size of Mira Ceti—includes, among other stars, our old friend Mizar—Zeta Ursa Majoris—the star which is located at the bend of the Great Dipper handle.

This star has many claims to distinction. It has an attendant, Alcor, about eleven minutes of arc distant, which is readily visible with the naked eye and has been known from antiquity as a test of normal vision. A nearer companion, only one-fiftieth as far away, makes it one of the finest of the wider double stars. Indeed, it was the first double star to be noticed with the telescope, in 1650. It was also the first spectroscopic binary. Pickering, in 1889, found double lines in its spectrum, which showed that the brightest star of the visual double was a very close pair with components moviag so rapidly that their velocity displaced the spectral lines. Later observations revealed that the period of this close pair is 20 days and 13 hours, that the orbit is highly eccentric and that the mean distance between the components is a little more than one-fifth of that between the earth and the sun.

The distance of the star is accurately known, since it belongs to the moving cluster of stars in Ursa Major. It is 72 light years.

From these data it appeared that the pair should just be resolvable with the interferometer, and Mr. Pease has found that this is indeed the case. Turning the beam carrying the mirrors in one direction, he finds perfectly sharp fringes, showing that the star has no measurable diameter. Setting the beam at right angles, the fringes disappear, proving that the star is "elongated" in a definite direction. This direction of elongation changed by 45 degrees in four nights, in excellent agreement with the known rule of motion of the spectroscopic pair in this part of the orbit.

Combining the spectroscopic data with the others, it appears that the orbit is inclined about 50 degrees to the plane of the sky, and that the separation of the two components, although really amounting to more than twenty-five million miles, appears in the heavens as only one-eightieth of a second of arc. The separation of so very close a pair—no farther apart, apparently, than two lights separated by an inch would look to be when seen at a distance of 250 miles—is one of the most brilliant triumphs of the interferometer.

The Fire Demon in Our Forests

Scientific Forest Fire-fighting, a New Profession

By Theodore M. Knappen

Photographs through the courtesy of the United States Forest Service

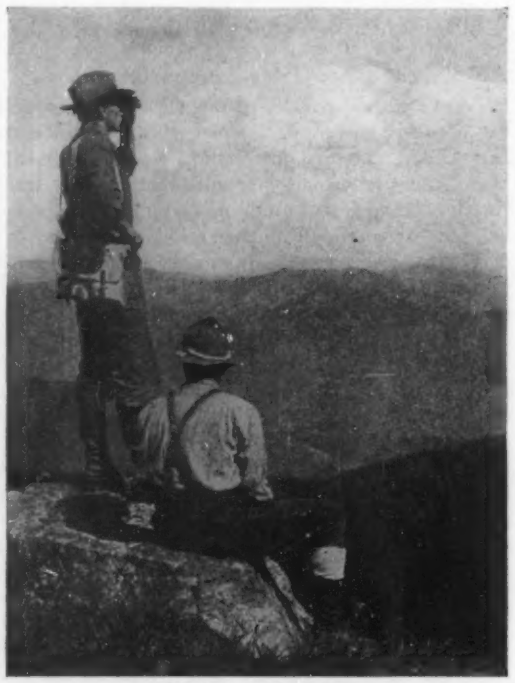
IT was in the sun-scorched Siskiyous of Northern California. Below a huge cloud of smoke, that rose high above the mountains and drifted slowly southward, the forest was red-lined with tree trunks turned to columns of ragged flame, which rose from the forest-floor, itself smoking, charred, and flashing with fire. The flames devoured the inrushing currents of air with a dull roar, which mingled with the crackling of quick combustion of brush and branches and ferns and the occasional crash of a falling snag or conquered tree.

The fire was not advancing in a furious charge; but its steady oncoming had the appearance of invincibility and certainty. The blackened, sweating fire-fighters, flailing vigorously with gunny sacks and doggedly wielding axe and shovel and mattock, retreated again and again, as they found that quick forward thrusts of flame had penetrated their line.

Humidity Is Fire Fighters Ally

In most battles with the red enemy of the forests the chief of the fire-fighters is a veteran whose long experience is fortified by scientific knowledge, equipment and training. The strategy, weapons and tactics of this sort of warfare are now fairly well evolved, and are being improved each year. Fire-fighting has become a scientific profession, which has enrolled hundreds of adventurous men who find in its hazards something of the lure of danger that was once an attribute of all life in the west.

All the strength and all the weakness of forest fires are understood. The leader of the fighters is well-grounded in the principles of the profession. He knows exactly what he will do, according to the topography, the nature of the forest, the moisture content of the forest-floor, the direction of the wind, the time of day and the humidity of the atmosphere. He loses no time in unnecessary movements; yet sometimes he leads his soldiers to the scene of the fire with all possible haste, only to do nothing but leisurely survey the foe, get ready for a good dinner and for a sound night's sleep. He does not believe in wasted effort. He perceives that all his men can do during the rest of the day will be more than done for them during the cool and dewy hours of the night.



LOOKING FOR SMOKE

A suspicious-looking haze in the distance—it may be just a cloud or again the smoke of a fire

Humidity is to the forest fire-fighter what temperature is to a doctor handling a fever case. Hence the importance of psychrometers, hygrometers, hygrographs, and hygrothermographs, and an understanding of what their records mean. When the humidity drops to 20—that is, when the air holds only 20 percent of its water capacity—the whole world about seems to explode in fire, and the general of the fire-fighters is apt to resort to prayer for rain or night, for either will bring him an increase of humidity. At 40 or below the atmosphere sucks the moisture out of the material of the forest-floor, the moss on the trees and even their leaves, and every falling spark and brand mean a new fire center. Sometimes there is nothing to do but quit the fight and run for it. The fire leaps ahead hundreds of yards at a time; the general advance may be thirty miles an hour.

Watchful Waiting

The Western Forestry and Conservation Association, an organization of lumbermen and timber owners in the Pacific Coast and Northwestern States, affiliated with the National Lumber Manufacturers' Association which has been fighting fires for years, sometimes spending as much as $2,000,000 a year for that purpose, has been gradually working out the technique of successful forest fire-fighting in co-operation with the United States Forest Service. It guards the last great virgin coniferous forests of America—the forests that must meet the nation's demand for lumber while new forests are growing to take their place. Should they fail for two or three years, generations yet unborn will

PUTTING OUT A GRASS FIRE

One person may check a small fire at the start, which, if neglected, may require hundreds

LOCATING THE FIRE

This ranger has seen a cloud of smoke and is using his compass and map to locate it

suffer for lack of wood, "the indispensable material of civilization." Progress in the science of fire prevention and suppression has been such that the Association now publishes "The Western Fire-Fighters Manual," which is a text-book of the science and the art of contending with forest fires.

Not many years ago the reporting of forest fire was chiefly a matter of chance. Someone happened to notice a fire and reported it to the authorities, if he thought it worth while. It often happened that a fire in a wild and uninhabited country got a big start before it came to the notice of any responsible official. Now, in the fully organized regions, such as that covered by the Western Forestry and Conservation Association, from 80 to 90 percent of all fires are first reported by regular lookouts, who from their permanent, elaborately equipped stations on the top of high peaks do nothing, day in and day out, but survey all the country round about for the slightest trace of a fire.

Within a few minutes after he has spotted the fire and made the necessary calculations to locate it, so that the fire-fighters can find it promptly, trained men are on the way. The lookout stays on the job, watching and reporting on the progress of the discovered fire and at the same time scanning the horizon for others. Thus the watch is never suspended by the lookout joining the fire-fighters, as in the old days when the lookout man was a patrolman, who occasionally visited certain commanding points, and then rushed off to the fire when he saw one. The lookout system is now almost entirely relied upon for the discovery of fires, except in certain restricted areas of high risk and great property value, where ground patrolmen reinforce the lookouts. Airplane patrols have been and will be used on occasion and in emergencies to supplement the work of the permanent lookout stations; but the necessity and superiority of continuous observation will always remain.

Crown Fires Most Difficult to Check

Whether the fire be large or small, the great object is to get to work on it before the heat of the day, or of the following day. In the cases of very extensive fires many crews are put in the field, each with its own camp, as a number of smaller crews, each located at a strategic point can do more effective work than when concentrated in one camp. About fifty men is the limit for a single camp, and fifteen to thirty is more common.

The first objective in the strategy of the fire warden in forest ranges, in command of a large operation, is not to save any particular body of imperilled timber, but to suppress the fire in the most dangerous part of its location. Fires in old burns and moss-laden timber, where the value is comparatively low, form the greatest risk and require the largest crews, for the reason that they spread with maximum intensity and are especially apt to result in crown fires, which means killing of all timber and the creation of a fire trap for twenty to thirty years. If not suppressed they spread over a large area, and any day may break into a conflagration that may ruin valuable timber many miles distant. Moreover, the best future protection that can be given the forests is the checking and stamping out of new fires in old burns, until

A FIRE IN ARAPAHO NATIONAL FOREST

In the foreground is the Moffat Tunnel Camp. Here is real danger for the powder magazines containing carloads of explosives

DEVASTATION AND DESOLATION

Ruins of a heavy stand of Idaho white pine timber in the Coeur d'Alene National Forest in Idaho

AIRPLANE ON FIRE PATROL

Because of its mobility and great range of vision the airplane is used for patroling

ON THE FIRING LINE

Forest officers fighting a "ground fire," which kills all timber in its path

reforestation has a chance to establish a new forest cover.

While humidity is the chief consideration in determining the moment of launching the counter-offensive against the fire, and the degree of intensity of effort against it at other times, the direction of the wind, the slope of the land, and topographical features such as ridges (fires advance more rapidly up than down hill), rivers, and so on, determine the place and method of attack when taken into consideration with the nature of the fire, which may be of three kinds—surface, duff, or crown. A surface fire is one that spreads rapidly over the ground, burning the quickly inflammable litter of the forest-floor, but not taking a hold in the lower duff. While a surface fire is hot, it is soon over; but a duff fire is persistent and requires a long time to burn out and put out. Crown fires are those in which the foliage of the trees is consumed, and they are the most difficult to check.

Various Methods of Attack

There are four methods of controlling a fire.

First. The direct method. This is a spade method and consists of shoveling in or digging out and throwing in the burning edge of the fire.

Second. The two-foot method, in which hazel hoes or mattocks are used to construct a cleared dirt belt about two feet from the burning edge.

Third. The parallel method, which consists of hacking and digging a continuous cleared zone down into the mineral soil, from six to fifty feet in advance of the fire.

Fourth. The indirect method, in which a similar lane is cleared of all standing trees, old "snags" or trunks, and all combustible matter, at a considerable distance from the edge of the fire; "back-fires" then being set in the intervening territory, thus creating a wide zone in which to check the advancing fire. A military analogy is the infiltration method used by the French to stop the last offensive of the Germans in July, 1918. Worn out in rushes through areas that were slowly surrendered to them according to plan, the Germans were crushed by a counter-offensive when they reached the actual French line.

Which of these methods to use is a matter of judgment by the chief of the fire-fighting crews, and many factors determine his judgment, which nevertheless must often be made without a moment's delay.

None of the foregoing methods of attack is efficacious in dealing with crown fires; as it is rarely possible to establish a cleared zone that is wide enough to stop a running crown fire. Crown fires seldom run at night, and therefore may be stopped during the night by checking the attendant ground fires and using torches to burn the highly inflammable moss off the trunks of exposed trees, so that there will be little chance for the fires to get into the crowns the next day. After the fire has been beaten it must be watched until all ground fires within 30 to 40 yards of the dead line have been put out and all "snag" fires within 75 to 200 yards are extinct.

About 3,500 forest wardens were on duty in the territory of the Western Forestry and Conservation Association, in California, Washington, Oregon, Idaho and British Columbia during 1923, and they successfully handled 7,000 fires, protected 235,000,000 acres (the territorial equivalent of France and Great Britain together) of forest land, supervised the protective burning of an enormous area of slashings resulting from logging operations, and secured the conviction of 525 violators of fire laws.

KEEPING COMMUNICATION OPEN

A system of telephone lines is of vital importance to successful fire-fighting

The destructive fires usually begin under such conditions of dryness of the forest-floor and low humidity of the air that they get a big start and much momentum before the fire-fighters are mobilized. Then, if wind and low humidity favor the fire, it becomes a roaring conflagration, engulfing vast areas in a few hours. Such were the fires that destroyed Hinckley, Minnesota, in 1904, and Cloquet in the same State in 1918, with the loss of 800 lives and an enormous amount of property. Such was the great Peshtigo, Wisconsin, fire of 1875 which destroyed 1,500 lives.

Complete Desolation in Four Hours

The story of the terrible destructiveness, the implacable fury, of a forest fire, and the consequences, is dramatically and laconically told to the tourist in the Olympic National Forest in Washington as he emerges from a dark and stately forest upon a horrifying waste and reads this sign:

"On the right, 14,000 acres of timberland were burned in four hours."

Such was the intensity of this fire, starting in a small brush heap, that it literally destroyed in four hours one of the heaviest stands of green timber in the world. Nothing but ghastly, shattered and blackened stumps and snags of great trees remain for twenty miles. All life was extinguished and a desert was made. Nature, unaided, will never restock this fire-made desert. The United States Forest Service has been compelled to re-plant the whole area.

Owing to the lack of funds, relatively little territory is as fully organized for fire-fighting as it should be. There is always a chance that a fire will get beyond control. Three cents an acre a year would practically wipe out all destructive forest fires. At present only one cent an acre is so spent by the public. But that, supplemented by such private agencies as the Western Forestry and Conservation Association, is to be credited for the existence today of virtually all the unburnt forests of the west. Were it not for what fire-fighting agencies we have, the fifty or sixty thousand forest fires that occur annually would eventually run over all the 470,000,000 acres of forest land in the United States.

Engine Balance

The First of Two Articles Giving a Diagrammatic Explanation of the Resolution of Forces for Counterbalancing Vibration

By P. Cormac, F.R.C.Sc.I.
Author of "Engine Balance Using Exponentials"

THE consideration of reciprocating masses raises a number of questions affecting a complete exposition of the factors which in an actual design would necessarily have to be worked out. Yet these factors can be assumed in general terms to cover a theoretical consideration such as we are giving here. For the purpose of lucid description we assume the mass to be concentrated and not distributed in application; the theoretical poising of the mass effect at a point.

Inertia of Rotating Masses

At the ends of its stroke the piston of an engine is momentarily at rest. In moving downward from the top dead center it has to be started from rest and its speed quickened up. It has then to be slowed down and brought to rest at the bottom dead center. These inertia forces are the ones which the engine frame has to withstand, and which cause it to vibrate when running.

It is an interesting fact that these inertia forces differ exceedingly little from the inertia forces of a certain set of rotating masses which will now be described. Let us suppose the piston fitted to two connecting rods which drive two cranks in opposite directions, as in Figure 1. In that figure the smaller circle has its center on the line of stroke and passes through the center of the crank circle, while its radius is $\frac{1}{4}n$ of the crank radius, n being the number of crank lengths in the length of the connecting rod. Now, if half the piston mass be placed at each crankpin, P, P^1, the centrifugal forces of these two rotating half-piston masses have a resultant nearly equal to the inertia force of the reciprocating piston M.

If, in addition to these half piston masses at P, P^1, we place similar masses running round the smaller circle keeping with the points S, S^1, where the cranks (or cranks produced) cut it, then, for all points of the stroke, the four rotating masses P, P^1, S, S^1, form a system giving to a high degree of accuracy the same unbalanced force on the engine frame as is given by the reciprocating piston. The equivalence is exact at the ends of the stroke. We shall call the large circle the primary circle and the small circle the secondary circle. It may be seen that the masses running on the secondary circle make two revolutions for each revolution of the cranks. From the formula for centrifugal force we can calculate the maximum hammering effect on the engine frame due to these primary and secondary rotating masses.

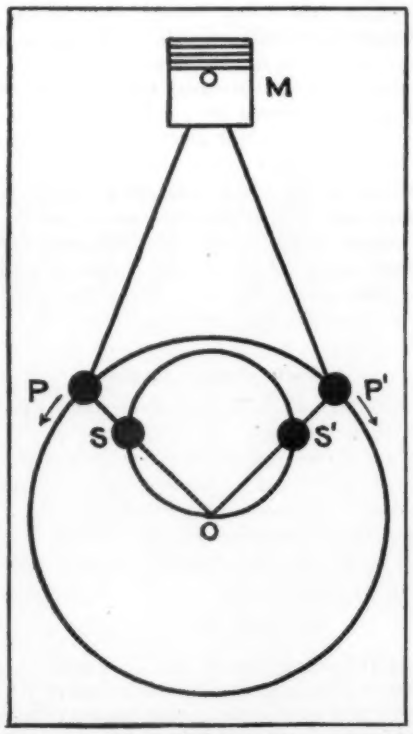


FIGURE 1. *The equivalent rotating masses of an oscillating piston*

What Part I Contains

Realizing the considerable interest in gasoline engine performance as evinced by the inquiries being constantly received by us, requesting information as to relative efficiencies of various types, and knowing the variety of expressions used in gasoline engine literature,—"balanced," "opposed," "straight-line," "silent," "non-vibrating," and so on—when Prof. Carmac was in this country to represent the College of Dublin at the Mathematical Congress and read his paper on "The Use of Exponentials in the Analysis of Machine Motions," we asked him to write an article on Engine Balance that could be understood without a great deal of mathematical knowledge.

An Example

For an engine having a piston mass of 2.31 pounds, a connecting rod ten inches long and a crank two and one-half inches long making 3,000 revolutions a minute, the maximum primary effect is a force of 1,475 pounds weight, and the maximum secondary effect is a force of 369 pounds weight. On the inner dead center the secondary and primary forces act in the same direction, so that the total unbalanced force on the incenter is 1,844 pounds weight. On the outer dead center, the unbalanced force is the difference between the primary and secondary forces and is, therefore, 1,106 pounds weight.

The principle of the primary and secondary rotating masses may be used in the design of a single-cylinder engine to counteract the effect of these large unbalanced forces. The necessary elements of such a design, giving an engine with good balance, are shown in Figure 2. Here the rotating masses used to balance the reciprocating piston are placed on the circles directly opposite to the positions given, in Figure 1. The rotating set in Figure 2 would in fact balance the rotating set in Figure 1.

In an actual design, the masses P^1, S, S^1 would be caused to perform their motions by some form of gearing. Owing to the necessity for the introduction of such a special mechanism to run the secondary masses and the reverse primary mass, an attempt is often made at partial balancing by using the direct rotating mass P alone which is placed on the production of the crankcheeks. With such an arrangement the want of balance corresponds to that given by the three omitted masses, namely, the two secondary rotating masses S, S^1, and the reverse rotating primary mass P^1. A better balance is got by using at P a balance weight (m/2 m/2n) which gives a centrifugal force equal to that of the primary mass P and the secondary mass S. On the incenter then, the want of balance is but the effect of P^1 and S^1 and this is by far the greatest hammer blow that occurs.

The principle of partial balance just described should be adopted not only for single-cylinder, but also for multi-cylinder engines, for it is best to balance each piston as far as possible independently of balance forces coming from adjacent pistons. In this way the crankshaft is relieved of having to transmit the very considerable total balance force for each piston from crankpin to crankpin. The partial balance mass is, of course, in addition to the counterbalance mass necessary to balance the crankcheeks, crankpin, and the large end of the connecting rod.

Multi-cylinder Engines

The replacement of the piston by primary and secondary rotating masses forms a convenient way of examining the balance of multi-cylinder engines. The line of stroke with its primary and secondary circles is drawn, and the reciprocating masses replaced by an equivalent set rotating on these circles. The balancing problem is then reduced to the examination of the balance of a set of rotating masses.

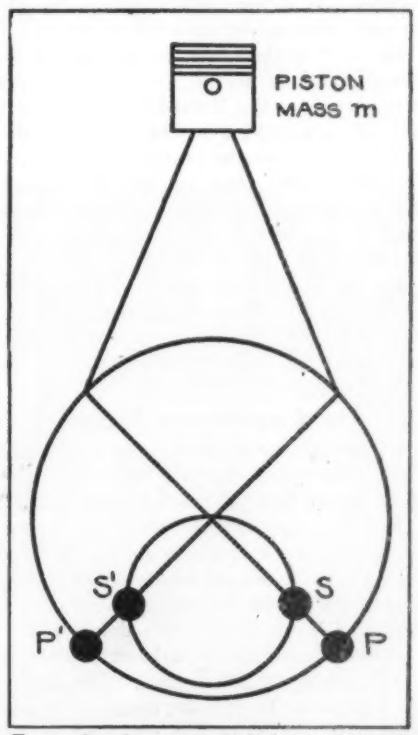


FIGURE 2. *A system which is practically in perfect balance*

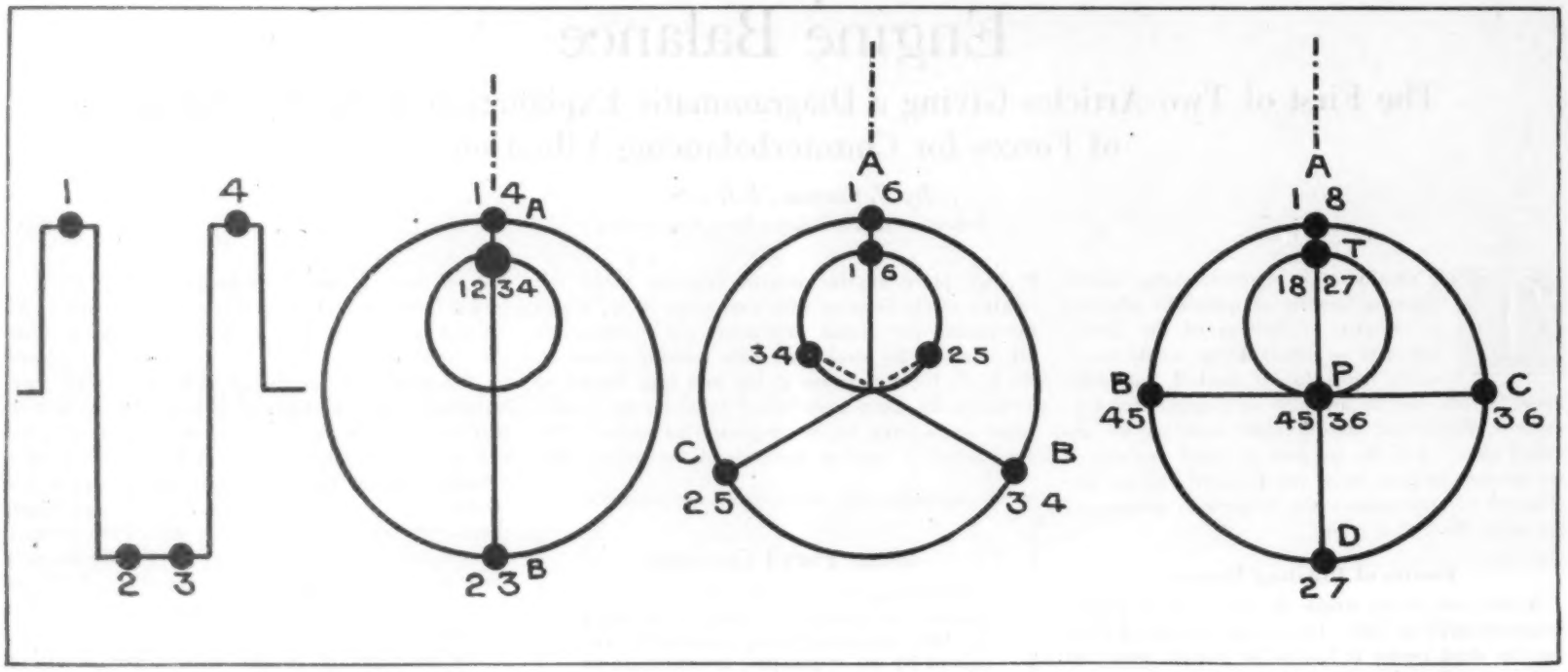


Figure 3. Four-cylinder crankshaft with rotating masses equivalent to the oscillating pistons

Figure 4. The rotating system equivalent to the pistons of the six-cylinder engine

Figure 5. Rotating masses equivalent to pistons of the straight eight

Taking the four-cylinder motor to begin with, we draw the two circles as in Figure 3. Now, if we draw the cranks on the dead centers, we will have cranks 1 and 4 cutting the primary circle at the top and cranks 2 and 3 cutting it at the bottom. Cranks 1 and 4 meet the secondary circle on the top. Cranks 2 and 3 must be produced to meet the secondary circle so that they, too, meet it on the top. The cranks being on the dead center, the positions of the reverse rotating masses coincide with the positions of the direct rotating masses. The inertia forces of the pistons are thus found to be equivalent to primary direct rotating masses at A and B and to primary reserve rotating masses also at A and B together with direct and reverse rotating masses at C.

The primary rotating masses are in balance because (1) the center of gravity of both the direct set and the reverse set is at O, the center of rotation, and because (2) if the crank members represented masses, these also would have the center of gravity at O, that is O is the center of gravity of masses one pound and four pounds at A and two pounds and three pounds at B. If condition (1) were satisfied and (2) were not, it would mean that the upward inertia force on the crankshaft was equal to the downward inertia force but that these equal and opposite forces acted at different points along the crankshaft's length, thus giving a pitching couple on the engine. The masses running on the secondary circle are not balanced as they are all on the one side of that circle. Thus, the primary inertia force of the four-cylinder engine is in balance but the secondary inertia force is not balanced.

The Four-cylinder Engine

For a four-cylinder engine having the dimensions given in the previous example the total maximum secondary inertia force is 1,475 pounds weight. Of course, as in the single-cylinder engine, the secondary forces of the four cylinders can be balanced by introducing rotating masses which would correspond with those rotating on the secondary circle. Some engineers consider it worth while doing this.

We will now examine the balance of six-cylinder motor with cranks at 120 degrees. The diagram is given in Figure 4. The cranks, number 1 to 6 along the crankshaft, are generally arranged as shown, those equidistant from the ends being parallel. The primary direct rotating masses for the cranks 1, 6; 3, 4; 2, 5; will be A, B, C respectively and clearly this distribution satisfies the two conditions for balance. The primary reverse rotating masses for cranks 1 and 6 will be at A, for cranks 2 and 5 at B and for cranks 3 and 4 at C. Here again we have all the conditions for balance satisfied. The direct rotating secondary masses are shown on the secondary circle. Clearly these are in balance, and it may easily be seen that the reverse rotating masses on this circle are also in balance. Thus, the six-cylinder motor has both its primary and its secondary inertia forces in balance.

The Straight Line Eight

The diagram for the straight eight-cylinder engine is shown in Figure 5. Starting from one end of the crankshaft and numbering the cranks 1 to 8, the arrangement of the throws in end view is as shown in the diagram, that is, cranks 1 and 8 with 2 and 7 would correspond to the ordinary four-cylinder crankshaft, while the cranks 3, 6, 4, 5, correspond to a second four-cylinder crankshaft placed at right angles with the first.

Now, examining the arrangement for balance we find that primary direct rotating masses are placed at ACBD and these evidently are in balance. The reverse primary masses would be those got by interchanging the crank numbers at C and B. These also are evidently in balance. The secondary masses for cranks 1, 8, 2, 7, are at T and the secondary masses for cranks 4, 5, 3, 6, are at P. The set at T plainly balances the set at P. Hence a straight eight with this crank arrangement is very well balanced.

There are two other arrangements of the straight-eight crankshaft which give complete balance. Numbering the cranks 1 to 8 along the crankshaft as before, the second arrangement gives in end view cranks 1, 8, at A (Figure 5) cranks 3, 6 at D, cranks 2, 7, at C, and cranks 4, 5, at B. The third arrangement gives cranks 1, 8 at A, cranks 4, 5 at D, cranks 2, 7 at C, and cranks 3, 6 at B.

A straight-eight crank arrangement which gives an unbalanced secondary couple on the engine frame is shown in Figure 6. Here the cranks 1, 2, 3, 4, are arranged as in the usual four-cylinder engine and these are followed by a similar set 5, 6, 7, 8 lying in a plane at right angles. That there is an unbalanced secondary couple is seen from the fact that the sum of the crank numbers at the top of the secondary circle is less than the sum of the numbers at the bottom of this circle. The difference between these sums gives the arm of the couple in terms of the cylinder pitch, the force being the secondary force of one cylinder.

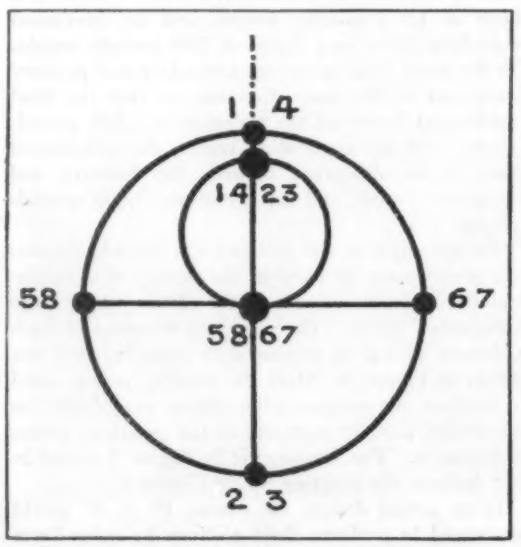


FIGURE 6. *A straight eight with unbalanced coupe*

Offset-cylinder Engines

A word may be said here about the balance of offset-cylinder engines.

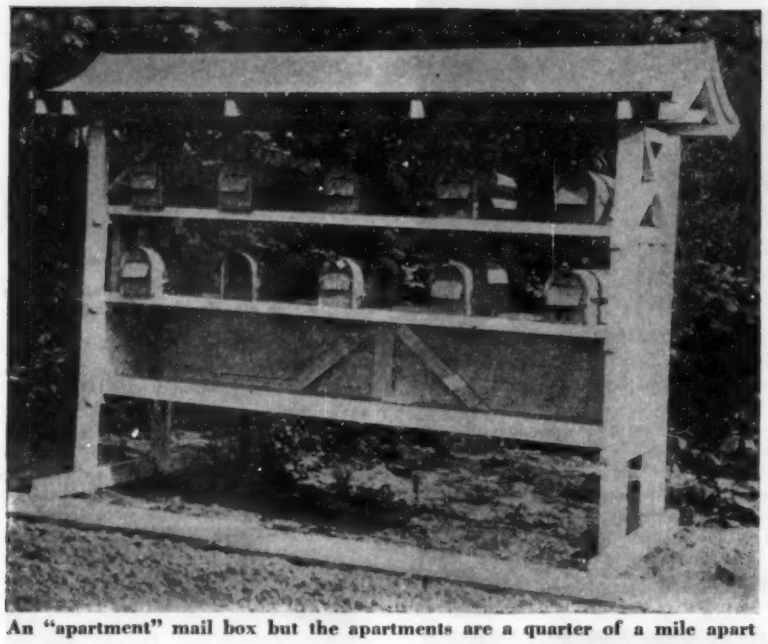
The inertia forces of the offset engine are given by direct and reverse masses running in circles slightly larger than the primary and secondary circles of the corresponding symmetrical engine. An offset engine has the same type of balance as the corresponding symmetrical engine.

¶ Part II *covering radial and V engines will appear in a subsequent issue. We believe you will agree with us that the author has made an extraordinarily lucid and comprehensible presentation of an extremely technical subject.*

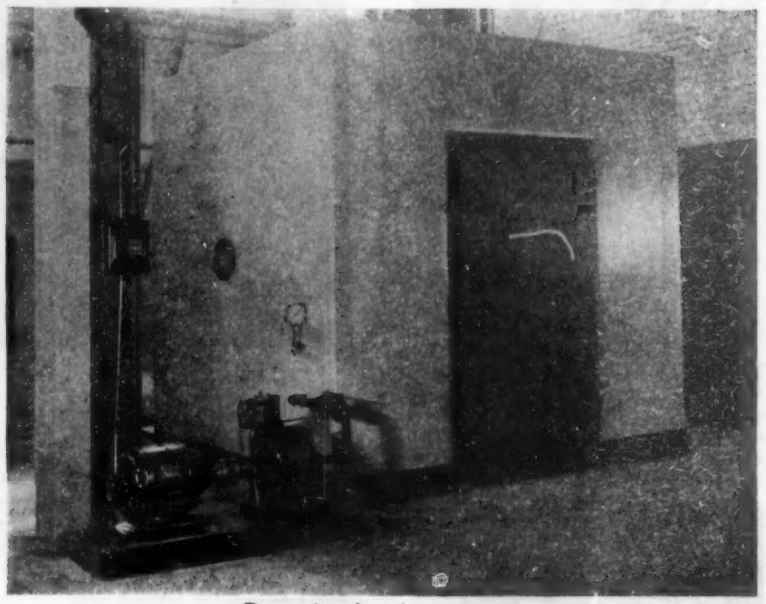
Inventions New and Interesting

A Department Devoted to Pioneer Work in the Various Arts and to Patent News

Conducted by Albert A. Hopkins



An "apartment" mail box but the apartments are a quarter of a mile apart



Preserving furs in a vacuum

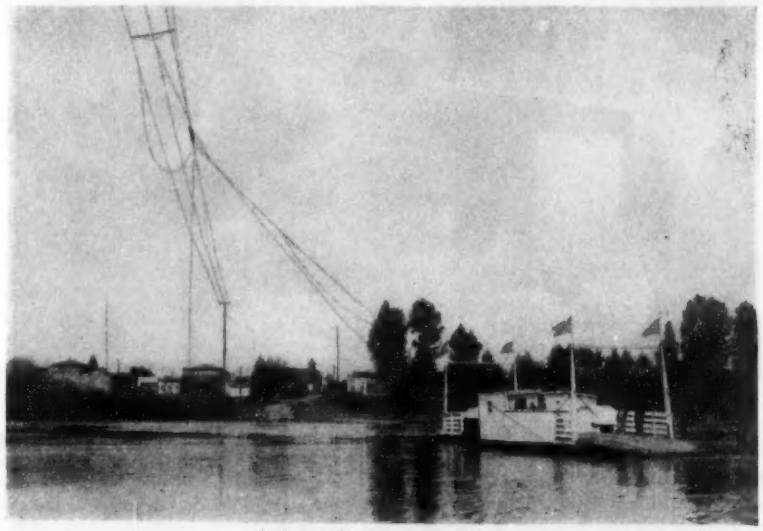
Making the R. F. D. Boxes Attractive

THE residents of Mercer Island in Lake Washington, State of Washington, grew tired of the usual unsightly mail boxes on posts and they got together and built the good-looking shelter shown in our illustration. This should be a hint to other localities.

Vacuum Storage of Furs

A NOVEL use for a vacuum has been discovered by a St. Louis storage man. An experimental room has been built in which rugs and other household furnishings are stored. The air is then partly exhausted, with the result that all insect life, such as moths, is unable to exist. Mice also die quickly as there is little oxygen in the air.

The room is 8 x 8 x 8 feet with walls eight inches thick and built of nonporous concrete. Glass peepholes are arranged on two sides for studying the effect of the vacuum on insect and animal life. A steel door is provided with special hinges and four screws with handles are used to hold the door securely until the air exhaustion begins. After a partial vacuum has been created, the door is drawn so tight from outside air pressure that no locks or fastenings are needed.



A ferry boat on a trolley

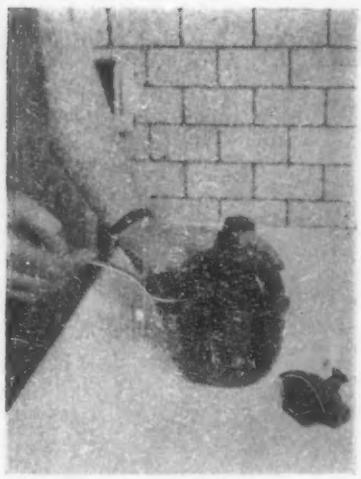
A Ferry Driven from a Trolley Line

THIS trolley-operated boat is running on the Willamette River at Independence, Oregon. The ferry boat is driven by a 20-horsepower motor, operated at 440 volts. The motor is connected to side wheels through a Fordson tractor transmission. Steel cables stretched across the river furnish the current.

Notebook Cover and Stand

A PATENT refill notebook cover that also acts as a stand for transcribing stenographers' notes. The leaves of the notebook are held in a graduated diagonal pocket without the use of clips or rubber bands. The notebook is placed in the cover and is not removed while taking notes or transcribing.

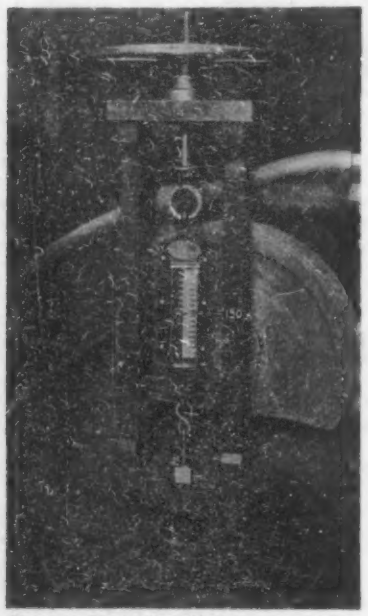
Speeding up the dictation—the notebook cover acts as a stand



A teapot that insures tea of the desired infusion

Tip-back Teapot

THE operation of this useful teapot is as follows: Put the tea leaves on the perforated shelf at the top, then in order to steep the tea, tip back the pot on its handle and the two button-like projections at the bottom. When the tea is properly infused, set the pot upright again—the leaves remain on the shelf—and the clear tea below keeps its desired strength.



Rotary chuck installed on a grinder

A rack for holding the morning newspaper

Rest for Newspapers

OUR paper falls on the floor about twice during breakfast, but if we had one of these little newspaper racks this would never happen, nor would we get occasional spots on the paper from coffee or egg. If you want to spread out the entire paper you can do so by throwing up the arm shown as folded in.

The above illustration shows several of the devices described on this page

Dishwashing in the Discard

WITH this cementer of domestic happiness exit dirty dishes—just throw them away! It has been estimated that in the average household nearly if not quite five hundred hours are spent yearly over the dishpan or sink, by someone. This device shows the white glazed-paper plate that serves four dishes at once, the partitions being shown. These plates (1) in themselves would perhaps be deformed by the food if it were not for the decorated tin tray (2) which is a part of the outfit.

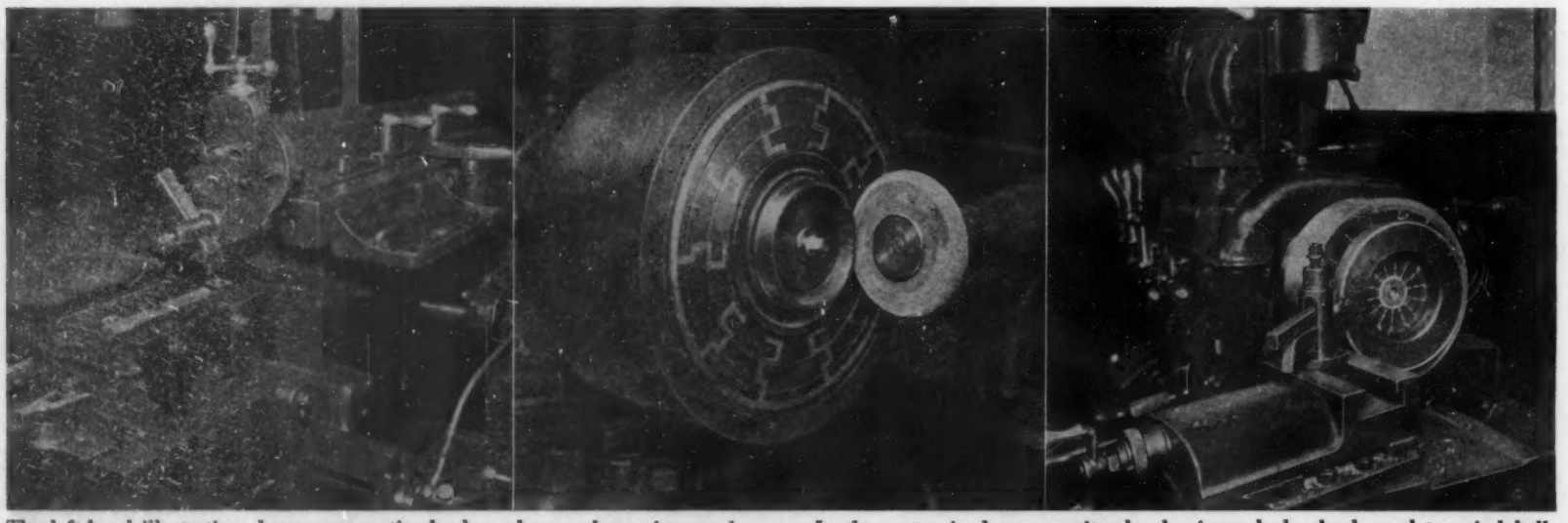
After the meal is concluded the "dishes" are thrown away. At (3) we have the tip-back teapot. The newspaper is shown at (4).

The principle of the tip-back teapot is clearly shown here

Hands Kept Dry While Mopping

IN the device illustrated here, the mop-head is attached to the end of a handle by one end, while the other end consists of a sliding sleeve, or socket, equipped with a button. This button engages in slots in the handle, making wringing an easy matter. By simply drawing the sleeve upward on the handle and then twisting the handle and the sleeve in opposite directions, the water is conveniently wrung from the mop, while the button engages the slots in the handle and keeps the mop-head tightly wound until it is desired to use the mop. Then, by simply turning the sleeve a trifle further, the button is released and the mop-head permitted to fall into the proper shape for mopping.

Hands kept dry while wringing



The left-hand illustration shows a magnetic chuck used on a shaper in a tool room. In the center is shown a unit-pole aluminum body chuck used to grind ball races. At the right is shown a ten-inch aluminum body unit-pole magnetic chuck working on a special lathe

Feet for the proper attachment of machine guards

Feet for Machine Guards, Racks and Tables

WHEN the editor of this department was going through a large radiator plant in Buffalo, New York, he noticed some very efficient feet for machine guards, stands, tables, and so on. Often a good guard fails in its mission on account of improper methods of attachment, and these feet render it easy to fasten the angle-iron, as there is a hole tapped for a machine screw which serves to hold the angle-iron. They also serve to hold stands or racks.

Novelty Window-shade Pull Chain

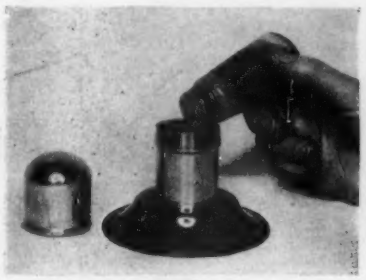
MOST window shades have rings or cords by which you can lower or raise the shade. Some shades even lack these essentials. A novelty shade pull has been invented that will fit on any shade made. It is a small ball chain about six or eight inches long with a bracket which fits into the wooden part of the shade and is clamped

A shade pull which may be quickly attached to any shade

on. On the lower end of the chain is a larger ball which serves as a sort of weight.

Combination Paper Weight and Mucilage Bottle

THE handy mucilage bottle illustrated rests in the top of a convenient paper weight for the office desk. The mucilage spreads a thin film right from the mouth of the bottle. This bottle is closed with a special gauze cloth, moist with the mucilage. The bottle is kept open and down in the container. There is no brush.



A handy mucilage bottle and paper weight combined

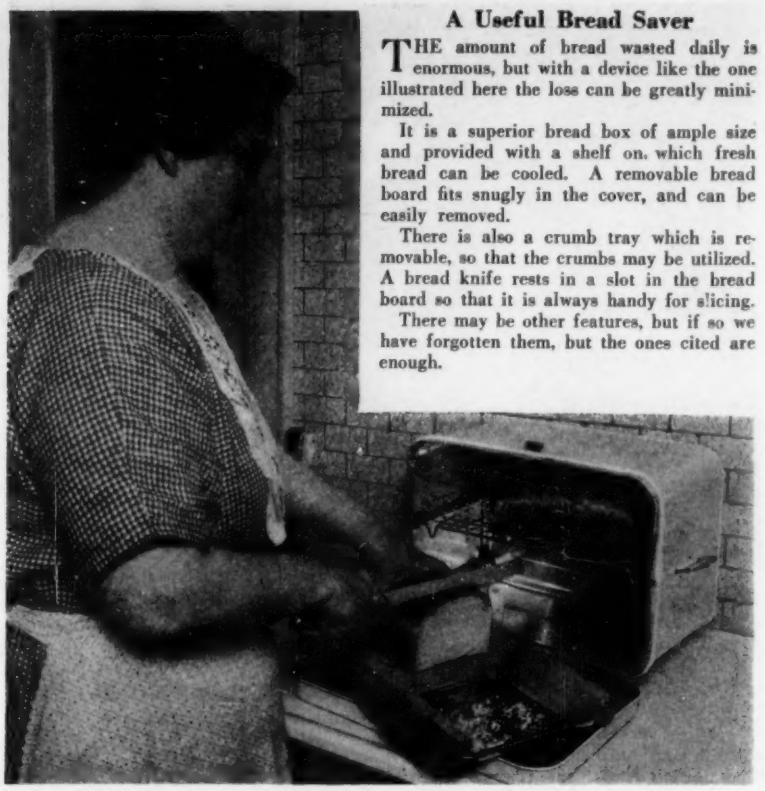
A Useful Bread Saver

THE amount of bread wasted daily is enormous, but with a device like the one illustrated here the loss can be greatly minimized.

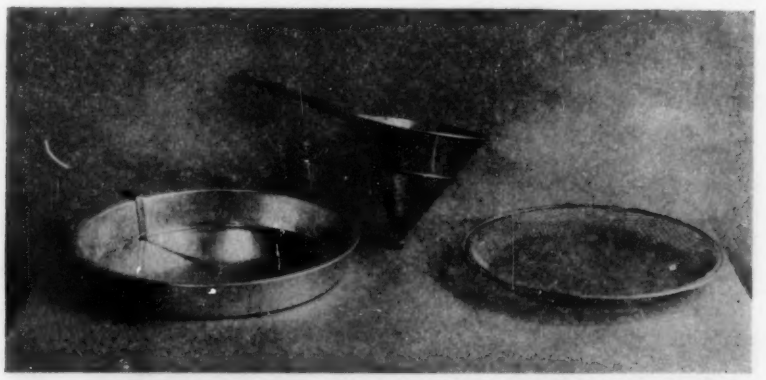
It is a superior bread box of ample size and provided with a shelf on which fresh bread can be cooled. A removable bread board fits snugly in the cover, and can be easily removed.

There is also a crumb tray which is removable, so that the crumbs may be utilized. A bread knife rests in a slot in the bread board so that it is always handy for slicing.

There may be other features, but if so we have forgotten them, but the ones cited are enough.



A bread box of ample size which is provided with a shelf on which fresh bread may be cooled, a removable bread board, crumb tray and a slot for the bread knife to fit into



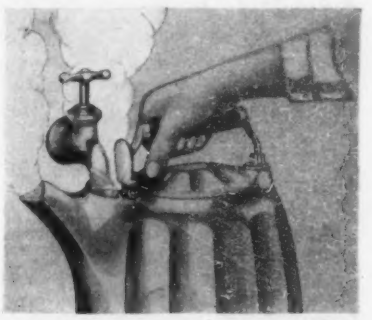
A cake pan, funnel and pie pan with unusual features

Some of the various shapes and sizes which the expanding casserole holder may be made into

Machine-guard feet used to hold a metal rack

Some Useful Tinware

A CAKE pan that can be freed of its contents by running the little separator around the circle, a funnel with wire mesh at the lower part and a wire-mesh pie plate are all articles the writer found in a large department store and which do not appear very often in the smaller stores. The funnel, of course, strains at the lower part where you want the straining done, and the pie plate allows the heat to penetrate the mesh so that the lower crust will not be soggy.

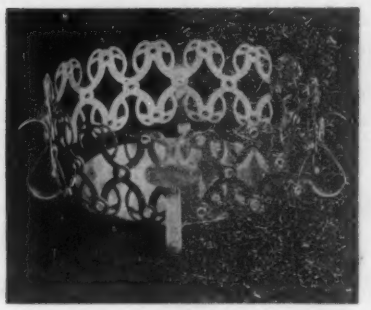


A kettle with a trap door behind the spout where the kettle may be filled without removing the cover

Expanding Casserole Holder

"UNEX" is a culinary contortionist in that it may be made to fit any casserole, round or oval, large or small, within a radius of six to nine inches. It has forty-seven joints which enable it to stretch into any sort of circle or oval.

The silver-plated holder is easily shaped as desired by pulling out the four supporting rods in the slots of the bottom plate. The outer ends of these are shaped into feet.



A holder which may be made to fit any casserole

In this washer the dishes are washed, rinsed and dried

Washing and Drying Dishes Without Wetting the Hands

THE washer illustrated is connected to the hot water faucet by means of a hose connection. With the aid of an electric motor, a vacuum is created inside the machine, surging the soapy water as the air is forced through, thus gently washing and steaming the dishes. The dirty dishwater is then drained off, and clean, hot water is turned on. By simply moving the small handle at the bottom which controls the spray, the dishes are then thoroughly rinsed. By a half turn of an air valve, air is taken in at the bottom and the dishes are fanned with a clean current of air until they are dry and polished without handling a single dish or using a towel.

A typewriter that permits of a complete change of carriage

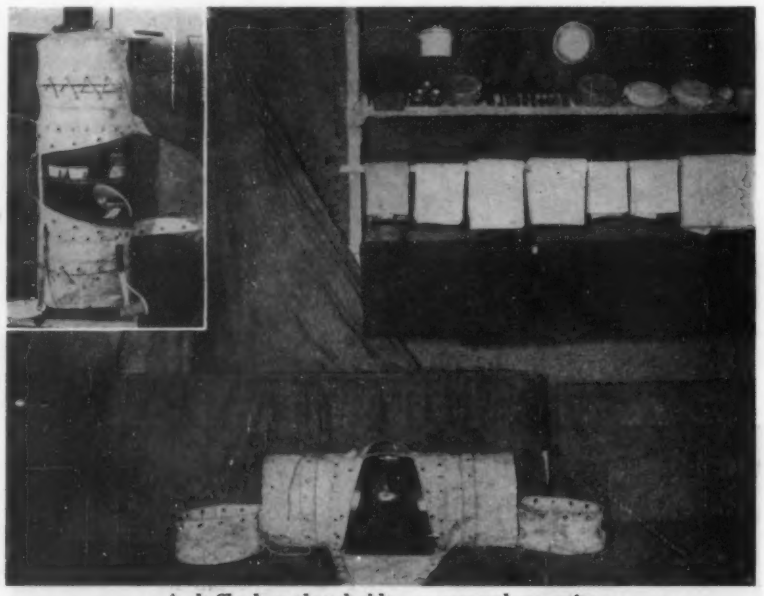
A Demountable Typewriter

ONE of the most radical departures in typewriter construction is found in a machine, where, by simply pulling a lock-lever at the rear, the entire base, deck and carriage can be removed from the action unit, providing a ready accessibility for cleaning and repairing. This typewriter also permits the entire carriage to be removed by pressing a single key and the margin release, and permits an interchangeability of various size of carriages, it is claimed. The platen is as easily removed (for cleaning or replacement with a steel platen for stencil-work) by lifting a clamp on each side of the carriage; and it is claimed that it is just as easy to remove and replace the deflector plate and feed rolls.

Guard for protecting adjacent surfaces in paint spraying

A Safety Paint Guard for the Sprayer

THE paint sprayer is here to stay, but, unfortunately, it is almost too uncanny in its efficiency and is apt to cover more territory than is desired. In the device shown, the guard limits the surface which is being treated. The guard is removable so that the sprayer can be used for white-washing, or for garden spraying.



A duffle bag that holds an unusual quantity

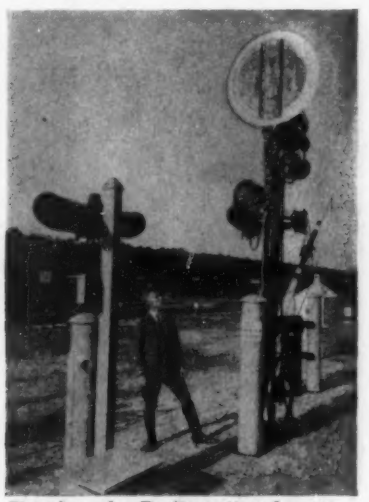
A Marine Corps Major's Idea of a Duffle Bag

FOR those people who wish to carry a considerable amount of luggage in the smallest possible space, the side-splitting duffle bag has been especially invented by a Marine Corps major who, incidentally, has also had a great deal of camping experience.

The bag consists of four units, as follows: A fibre suitcase of the Gladstone bag type which can be used separately, if desired, a middle section of canvas which covers the suitcase, with a flat opening giving access to the bag without disturbing the end packs. The bag ends are laced to the middle section and can be used as waterproof water buckets, wash basins, and so on, when not carrying luggage.

The first picture shows the easy accessibility of the bag. The second photograph gives an idea of the amazing amount of dunnage that can be carried in the bag.

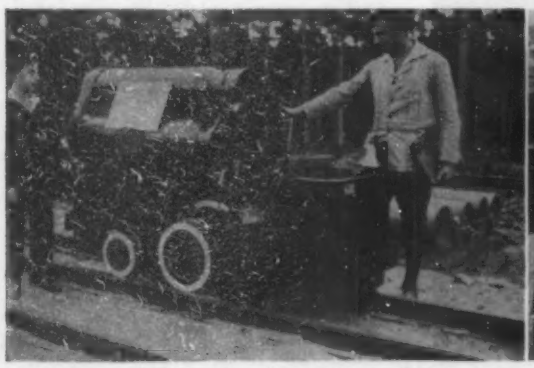
A close-grip trouser holder



Signal at the Berlin railroad exposition. The signal requires no attention day or night

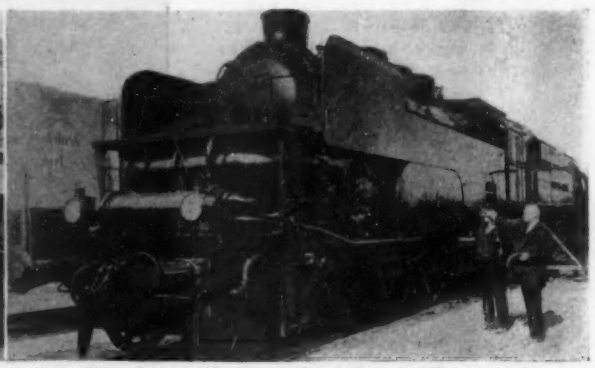
A Tight Gripping Pants Hanger

PANTS hangers are usually of such feeble construction that a touch sends the garment to the floor. Not with the hanger we illustrate, however. The fastener is forced down over a series of points like a ratchet, thus insuring a close grip.



The recent Berlin railroad exposition offered many novelties such as this compressed air locomotive

The exhibition in the open air attracted much interest, particularly the locomotive



A turbine locomotive turned out by the Krupps plant at Essen, Germany

Recently Patented Inventions

Classified Advertising

Advertisements in this section listed under proper classifications, rate 25c per word each insertion; minimum number of words per insertion 24, maximum 60. Payments must accompany each insertion.

Official copies of any patents listed in this section at 15c each; state patent number to insure receipt of desired patent copy.

Pertaining to Apparel

COMBINATION CORSET AND BRASSIERE.—Consisting of a garment which is joined at the side, comfortable to wear, and giving smooth straight lines to the figure. Patent 1534950. Mae Hernandez, 297 Sumpter Ave., Brooklyn, N. Y.

HOSE SUPPORT.—Including an elastic leg encircling band and an anti-slipping member, to which is attached a hose supporting strap. Patent 1533951. B. P. Seeger, 5650 De-Longpre Ave., Los Angeles, Calif.

BUCKLE STRAP.—For strap belts as worn around the waist, a tongueless buckle securing an adjustment at various positions. Patent 1533924. H. A. Krezdorn, Seguin, Texas.

Chemical Processes

BROWN SULPHUR DYESTUFFS.—A coloring product having a red tinge, consisting of treating crude trinitronaphthol with a polysulphide of an alkali metal. Patent 1531925. L. Haas, c/o C. Chassevent, 11 Boulevard de Magenta, Paris, France.

Electrical Devices

FUSE CHANGER.—Adapted for handling fuses used in connection with high voltage electrical circuits. Patent 1531567. T. E. Niblock, 1305½ 3rd Ave. No., Great Falls, Montana.

LOCK FOR TELEPHONES.—In the form of an attachment preventing the movement of the receiver supporting hook. Patent 1531,906. O. Duryea and L. LeMaire, c/o Tel-O-Gard Co., Room 237, 2025 Broadway, New York, N. Y.

ELECTRIC LANTERN.—Constructed with a supporting standard and a rigid handle, especially adapted for trainmen. Patent 1531900. A. E. Barber, c/o Barber Electric Co., 1352 No. Wells St., Chicago, Ill.

DRY-CELL BATTERY.—Such as are commonly used in connection with flashlights, constructed with two telescopic containers for the positive and negative elements. Patent 1533012. H. M. Koretzky and B. H. Teitelbaum, c/o Bright Star Battery Co., 15th and Riverhead, Hoboken, N. J.

DEVICE FOR ELECTRICALLY ILLUMINATING CARD CABINETS.—Adapted to be brought into action by the pulling out of a cabinet drawer. Patent 1532935. J. S. Patton, University, Va.

CIRCUIT-BREAKING TERMINAL.—For low voltage circuits, whereby the circuit may be readily broken to prevent losses, leaks, open grounds, etc. Patent 1533972. G. H. Clark, 1246 57th St., Brooklyn, N. Y.

GAUGE OR LEVELING DEVICE FOR ELECTRIC OR OTHER DRILLS.—By means of which a drill may be positioned in a vertical plane, and the hole drilled straight. Patent 1533,975. C. A. Dene, Lambertville, N. J.

AIR COMPRESSOR.—Which will effectively cool an electric motor and compressor by the action of a fan. Patent 1533958. C. M. Tursky, 41 W. 90th St., New York, N. Y.

KEY CONNECTION FOR THE WIRELESS TRANSMISSION OF MESSAGES.—Which permits the load of a generator to be maintained steady. Patent 1535046. O. Scheller and R. Herzog, c/o F. Warschauer, 111 Gitschiner St., Berlin, S.W. 61, Germany.

METHOD FOR HIGH FREQUENCY TELEPHONE WITH OR WITHOUT LINE.—In high frequency telephone circuits a closed core coupling coil, in the core of which the closed circuit magnetization is adjusted to the most favorable value, by a special device. Patent 1535037. L. Pungs, c/o F. Warschauer, 111 Gitschiner St., Berlin, S.W. 61, Germany.

Of Interest to Farmers

WEEDER.—Of light draft and easy adjustment so that the blades may cut at any desired depth. Patent 1533918. M. D. Kast, 616 Calvin St., Pendleton, Oregon.

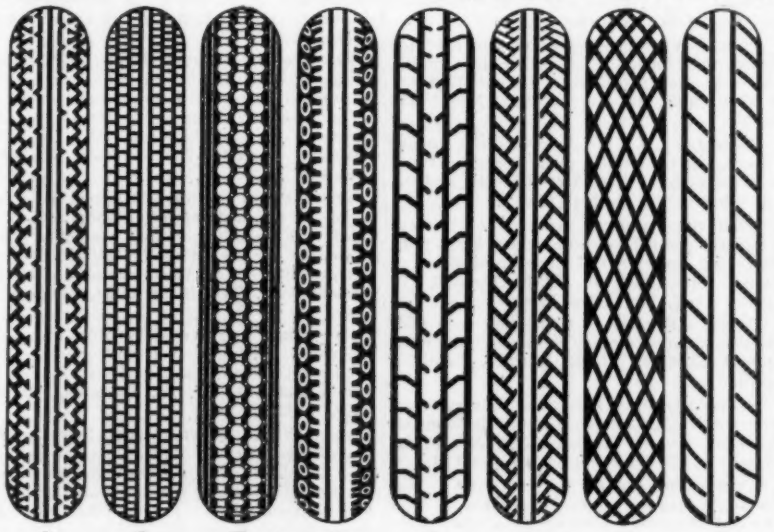
News for Inventors

A Department of Facts and Notes of Interest to Patentees and to Owners of Patent and Trademark Rights

Conducted by Milton Wright

Design or Trademark?

HERETOFORE automobile tire manufacturers have been protecting the designs of their tire treads by design patents. Now, Assistant Commissioner Fenning holds in the application of the Fisk Rubber Company that they may register the design as a trademark.



The Patent Office holds that the public recognizes the make of an automobile tire by the tread design. How many of these well known tires can you name?

"William C. Potter, being duly sworn, deposes and says that he is the acting director of the War Department of the United States of America, the applicant named in the foregoing statement; that he believes the foregoing statement is true; that he believes said corporation is the owner of the trademark sought to be registered; that no other person, firm, corporation, or association, to the best of his knowledge and belief, has the right to use said trade-mark in the United States, either in the identical form or in any such near resemblance thereto as might be calculated to deceive; that said trade-mark is used by said corporation in commerce among the several States of the United States and between the United States and foreign nations; that the description and drawing presented truly represent the trade-mark sought to be registered; and that the specimens show the trade-mark as actually used upon the goods."

"Applicant points out the common practice among dealers and the public generally to recognize and distinguish tires of various makers by the form of the tread applied to the non-skid tire," he says. "It seems clear that the particular form given to such a tread does, in the mind of the public, indicate source or origin. When the particular shape is not made the subject of patent, so that it is dedicated to the public at the end of the patent period, I am unable to find any logical reason why the form of the tread itself should not be considered a trademark by this office, especially in view of the fact that it is commonly so considered in the trade and by the public."

The practical advantage of the decision is this: a design patent runs for not more than fourteen years, at the end of which time the design becomes public property; a trademark runs for twenty years and may be renewed again and again, giving perpetual prima-facie protection.

Is the U. S. A. a Corporation?

IS the United States a corporation? Can it register a trademark as such?

Yes, is the answer of the Patent Office to both questions.

A well-known patent attorney has just dug up the certificate of registration for the trademark "Liberty," dated June 17, 1919. It is allowed for internal combustion engines and parts thereof. Registration was made upon the following sworn declaration:

Hats Are Not Clothes

IS a hat an article of clothing?

No, rules Judge Oliver B. Dickman in the United States District Court in Philadelphia. It's men's wear.

The case at bar was that brought for alleged trademark infringement by Rosenberg Brothers & Co., clothing manufacturers of Rochester, N. Y., against John F. Elliott, who conducts a men's furnishings store at Shenandoah, Pennsylvania. The clothing firm sought an injunction to restrain the haberdasher from using the trademark "Fashion Park" on hats and caps.

If hats are clothes the mark cannot be used. If hats are not clothes there is no infringement. A hat, the court holds, may be called furnishings, apparel or haberdashery, but never clothing.

POTATO DIGGER.—Providing an attachment, which may be secured to any conventional type of moldboard plow, to form a digger. Patent 1531907. F. H. Edmonds, 710 W. 13th St., Vancouver, Wash.

SEED-COTTON CONDITIONER.—Having means whereby to remove excessive moisture, and prevent the clogging of the gin saws, and consequent loss of lint. Patent 1533903. P. H. Rylander, 1000 E. 6th St., Austin, Texas.

MOWER ATTACHMENT.—Which may be arranged rearwardly of the finger bar, to remove and collect the seed from material cut. Patent 1533721. R. C. Becton, Dyer, Tenn.

Of General Interest

TOY MOUTH STRUCTURE.—Which provides means for opening and closing the mouth of a stuffed toy animal. Patent 1529376. S. H. Rosenthal, 402 E. 3d St., New York, N. Y.

ADJUSTABLE PRICE TAG.—Arranged so that any combination of three figures may be produced and changed as desired. Patent 1527382. J. Snyder, 1550 Jackson St., San Francisco, Cal.

COMPOSITE ROOFING.—Adapted to be built up and laid as a unitary waterproof and fireproof structure. Patent 1529463. J. R. Burnside, 301 Drexel Bldg., Tulsa, Okla.

PIPE OR CONDUIT.—Especially constructed for the efficient transfer of heat from one material to another. Patent 1528859. C. C. Taylor, Oak St., Mounds, Ill.

SHINGLE.—Formed in such manner that each shingle engages adjacent shingles to prevent curling, thereby forming a leak-proof roof. Patent 1529530. R. L. Wyatt, c/o 67 Shingle Co., Williamson Bldg., Florence, S. C.

SCREEN CONSTRUCTION.—Which may be removably secured to two bolts carried by a window frame, and manipulated from inside the window. Patent 1529073. G. L. LeRoy, P. O. Box 1042, Chicago, Ill.

WINDOW BOX.—For holding foods, adapted to be placed inside a room by partially raising the lower sash, yet preventing drafts. Patent 1530384. M. J. McArthur, 13456 Euclid Ave., Cleveland, Ohio.

PENCIL HANDLE.—Having both ends adapted for holding lead so that two different shapes may be used. Patent 1530305. E. E. Da Parma, 2138 Belmont Ave., Bronx, N. Y.

CONVERTIBLE CHAIR.—Which will easily permit of expansion so as to form a bed or divan. Patent 1530420. W. Schmitt, 523 Madison Ave., New York, N. Y.

TOBACCO-USERS' APPLIANCE.—Including a pipe scraper, a cleaning needle, and tobacco stuffer adapted to be conveniently carried in the pocket. Patent 1530348. J. A. Blom, Charlotten Strasse 58, Berlin S. W., Germany.

HEEL LIFT FOR FRENCH HEELS.—Which may be secured in place by a single fastening member penetrating the heel. Patent 1530,159. L. G. Fletcher, 224 No. 5th St., La Fayette, Ind.

COLLAPSIBLE WARDROBE.—When folded, resembling an ordinary suitcase, in which clothes may be transported without requiring repressing before use. Patent 1528173. H. W. Wagenet, 2428 E. 23d St., Oakland, Calif.

BOBBIN.—Wherein the thread wound thereon may be dampened or otherwise treated to prevent kinking when unwound. Patent 1530433. A. Stadler, c/o H. R. Mallinson & Co., 299 5th Ave., New York, N. Y.

FISH LURE.—Which when moved through the water will rotate about its axis to attract fish. Patent 1530835. F. L. Koepke, Box 18, Ridgefield, Wash.

BILL FOLD.—Or currency pocket-book, so constructed that the bills may be compact, yet one may be extracted without disturbing

any others. Patent 1530811. B. A. Brown, c/o Commercial Press, 131 No. Broadway, Albert Lea, Minn.

HAIR CURLER.—Particularly adapted for curling locks of bobbed hair, and also long hair. Patent 1530854. L. P. Putt, c/o Bobbsy Novelty Co., Toronto, Ohio.

FLOOR-POLISHING DEVICE.—For effectually cleaning and polishing hardwood and waxed floors when brought into rolling contact therewith. Patent 1530930. E. J. Burch, 223 Madison Ave., Memphis, Tenn.

GUARD RAIL FOR STATION PLATFORMS.—Providing means adjacent the edge of subway or other railway platforms, for preventing passengers being forced to the track. Patent 1531118. H. E. McManus, 1 Chestnut Ave., Bogota, N. J.

EDUCATIONAL APPARATUS.—Comprising a sheet metal plate, and a plurality of magnetized pieces, which may be moved to form characters or designs. Patent 1531070. F. C. Bruns, 10215 86th Ave., Richmond Hill, L. I., N. Y.

ATTACHABLE BASEBALL COVER — Which may be applied to a ball without stitching, when the original cover has been removed or broken. Patent 1531162. T. Valero, 1862 Jerome Ave., Bronx, N. Y.

LOOSE-LEAF BINDER.—Constructed in such manner that the mechanism is not permanently secured, making the parts detachable. Patent 1531204. J. McLaughlin, c/o M. M. Kallman, Room 323, 522 5th Ave., New York, N. Y.

TELEPHONE-RECEIVER HOLDER.—For supporting a receiver in such a way that both hands of the speaker are free. Patent 1531,190. L. Kalina, 1308 Ave. N, Brooklyn, N. Y.

ICE CREAM CABINET.—Especially adapted for a quick insertion of the ice cream containers, may be readily drained and cleaned. Patent 1531215. J. E. Oest, deceased; Mrs. J. E. Oest, executrix, 64 Bainbridge St., Brooklyn, N. Y.

VENTILATING GLASS WINDOW PANE.—Adapted to be glazed in existing pane spaces, and having baffle members to prevent the entrance of rain. Patent 1531197. L. Lane, Box 1066, Habana, Cuba.

BASKET.—Of open construction, and castle-like appearance, for packing and display of fruit, such as artichokes, apples or pears. Patent 1529110. D. Bloom, 1538 Edith St., Berkeley, Calif.

MOTHPROOF BAG.—Which when opened, keeps itself fully extended so that articles may be easily inserted or removed. Patent 1532046. W. C. Deiss, c/o White Tar Co., 56 Vesey St., New York, N. Y.

SAFETY DEVICE.—Adapted to be employed in connection with a safety chamber and provide means of escape from a submerged vessel. Patent 1531331. E. Bessette, c/o A. M. Surhrenant, 201 Oak Hall Bldg., Pawtucket, R. I.

FASTENING, SEALING AND LABELING DEVICE FOR RAILWAY WAGONS OR THE LIKE.—Applicable to any opening fitted with a hasp and staple fastening, sealing the opening while device is in place. Patent 1529775. R. J. Dennett, c/o Messrs. Remfry & Son, Post Box 161, Calcutta, India.

VANITY CASE.—Having a cosmetic compact ejecting member constructed in such manner that it is retained within the receptacle. Patent 1531953. W. G. Kendall, 118 Market St., Newark, N. J.

REFLOATING APPARATUS FOR STRANDED VESSELS.—So arranged that the action of the waves will be utilized to produce a lifting action. Patent 1531946. C. J. Jacobsson, 147 E. 33rd St., New York, N. Y.

SHOE FASTENER.—Which can be readily slipped into the eyelets of a shoe to take the place of an ordinary lace. Patent 1531,461. K. Uyeda, c/o T. H. Knight, N. Y. Ave., White Plains, N. Y.

CUE TIP.—The cue having means for effecting a positive connection with the tip. Patent 1532985. A. E. Bradley, 794 Lafayette St., Bridgeport, Conn.

SWIMMING BELT.—Capable of being worn so as to be concealed from view. Patent 1532970. E. Walker, 387 Nelson Ave., Grantwood, N. J.

UMBRELLA.—With improved construction of rib fulcrum and coupling means, whereby the rib coupling is prevented from turning movement. Patent 1533054. A. W. Wolfson, 935 Broadway, New York, N. Y.

CEILING VENTILATOR.—Adapted for use in kitchens and elsewhere, the device being readily fastened against a ceiling. Patent 1532635. J. E. Osbun, 175 Rosewood Ave., Riverside, Calif.

AUTOMATIC CUT-OFF AND CUT-IN VALVE.—For automatically cutting off the supply of gas in case of fire and turning on the sprinkling system. Patent 1532615. E. C. Wills, 330 Grove St., Newark, N. J.

COUPLING.—Adapted to connect one end of a ribbon band to the link of a wrist watch, without stretching the band. Patent 1532511. M. N. Melts, 19 Peachtree St., Atlanta, Ga.

HOSE HOUSING.—Which affords facilities for supporting a garden hose in coiled formation, and in sheltered position, without detaching the water connection. Patent 1532177. W. V. Gist, 2105 Lafayette St., St. Joseph, Mo.

WINDOW PROTECTOR.—For bracing the panel so that the pane is not likely to be broken by wind pressure or like stresses. Patent 1532472. P. P. Brown, Henry Hotel, Lusk, Wyoming.

BRIDLE BIT.—Affording facilities for guiding and controlling the movements of an animal without injury to a tender mouth. Patent 1532622. E. Erickson, Box 291, Philipsburg, Mont.

Hardware and Tools

ADJUSTABLE HINGED SPANNER WRENCH.—Particularly adapted for turning round nuts, adjustable to different sized nuts, and reversible for turning either way. Patent 1528691. A. C. Price and A. J. Thompson, 217 So. 3d St., Colwyne, Pa.

LOCK.—Wherein means are provided for preventing jimmying or otherwise forcing the bolt out of position. Patent 1528689. J. E. Phillips, 260 Convent Ave., New York, N. Y.

SASH LOCK.—Which prevents the further opening of a partially open upper or lower window sash. Patent 1528705. H. Sonner, 15 Whaley St., Maspeth, N. Y.

RADIATOR CARRIER.—Adapted to be conveniently applied to steam or hot water radiators for carrying the same from place to place. Patent 1528149. F. E. Grosvold, 411 Grand Ave., Eau Claire, Wis.

CATCH.—For use in connection with sliding doors, gates or other closures of this type. Patent 1529364. R. R. Mattice, Paullina, Iowa.

RELIEF-VALVE IN FAUCET.—To serve as a safety device in connection with the common form of faucet. Patent 1527358. J. A. Hamilton, 170 Diamond St., Fresno, Cal.

EAVES-TUBE-STRAINER FASTENER. — For holding a strainer against displacement from the end of a roof leader or drain tube. Patent 1529080. V. J. Niele, 4109 Winterburn St., Pittsburgh, Pa.

SAFETY HOOK.—So constructed that a rope or cable may be readily taken from the hook, but not accidentally displaced. Patent 1530010. A. H. Neilson, 417 E. 1st St., Tulsa, Okla.

LOCK NUT.—Having wedge means to tightly bind the nut on a bolt. Patent 1530,396. D. O'Brien, Punta San Juan, Cuba.

BRACING TOOL FOR TENNIS-RACKET FRAMES.—Capable of being associated with the racket frame by a single workman, for the purpose of stringing the racket. Patent 1530361. A. B. Harris, 522 5th Ave., New York, N. Y.

Machines and Mechanical Devices

RECORD CLEANING ATTACHMENT. — For phonographs, attachable independently of the tone arm and adapted to all makes of machines. Patent 1529507. J. Runk, 235 So. Main St., Silverwater, Minn.

COMBINED HOLDING AND MOUNTING DEVICE FOR MAINSPRINGS.—The inventor has been granted two patents of a similar nature, which provide a simple and efficient combined device for holding and mounting the mainsprings of watches and the like. Patents 1529385 and 1529386. A. J. Anderson, 2 Maiden Lane, New York, N. Y.

BABBITTING DEVICE.—Having particular reference to a device for babbitting the crank pin bearing of a connecting rod. Patent 1527361. E. W. Jones and H. W. Smith, c/o Automatic Bearing Machine Co., San Jose, Calif.

SPROCKET WHEEL.—Constructed in such manner that the teeth can be firmly adjusted radially to vary the effective diameter or pitch. Patent 1530403. A. J. Parsons, Tenn. and Ann Sts. and Mich. Ave., Mobile, Alabama.

TAPE PRINTING AND MOISTENING DEVICE. In which the printing roller may be changed at will and the moistening device adapted to any width of tape. Patent 1529130. W. F. Inman, 1442 N. Lotus Ave., Chicago, Ill.

RUBBER-CUTTING MACHINE.—For cutting rubber or other flexible material, and particularly adapted for cutting tubes into bands. Patent 1528446. C. B. Martin, 1129 6th St., N. W., Canton, Ohio.

MACHINE FOR SHARPENING WITH A GRINDSTONE CIRCULAR AND BAND SAWS.—Which automatically sharpens saws having teeth of any profile and separated from each other by any intervals. Patent 1530378. J. T. Lanfranchi, c/o C. Chassevent, 11 Boulevard de Magenta, Paris, France.

COTTON PICKER.—The machine will straddle a row and may be easily adapted to picking from short or tall cotton plants. Patent 1530151. H. N. Berry, c/o H. A. Gamble, Greenley Bldg., Greenville, Miss.

FEED TIP FOR LUBRICATORS.—Adapted for application to a lubricator attached to a rotating or oscillating part, and with means for controlling the flow. Patent 1530156. T. W. Crane, Imperial, Calif.

EGG-PROCESSING APPARATUS.—In which, by a sequence of steps, the eggs are washed, brushed, dried, and otherwise treated. Patent 1530415. W. H. Roussel, 152 Clay St., San Francisco, Calif.

WINDMILL. — Equipped with automatic means for controlling the blades whereby to compensate for variations in the velocity of the wind. Patent 1530399. O. Olsson, Ord, Nebraska.

PROCESS FOR FORMING WELLS.—Providing means whereby water containing sand may be pumped without delivering sand where it is not wanted. Patent 1529964. M. L. Proctor, deceased; address Mrs. E. M. Crowley, executrix, 200 Jefferson St., Elkhart, Ind.

VENTILATING DEVICE.—Designed to be inserted in the wall of a building, and provided with an automatically controlled inlet and outlet for air. Patent 1529711. W. C. Parrott and O. N. Hesselmann, c/o O. L. Hesselmann, 1734 Bennett St., Dubuque, Iowa.

SAW-STRETCHER ATTACHMENT.—For saw stretching machines that will allow saws, particularly band saws, to be straightened. Patent 1529120. M. W. Edwards, Albion, Calif.

MECHANICAL DEVICE FOR SIMULATING WATER-PROJECTION.—Which may be readily used in show windows without the disadvantage of moisture, the artificial stream is readily replacable. Patent 1531145. L. Shogran, 850 Grace St., Chicago, Ill.

POWER APPARATUS.—That can be normally used as a siphon, but very easily changed into a centrifugal pump. Patent 1529106. J. Anderson, Clarksburg, Calif.

FRUIT CUTTER.—That will split in half such fruit as peaches, plums and cherries and remove the pit. Patent 1529127. J. W. Haller, Anderson, Calif.

UNIVERSAL WORKHOLDER.—Which may be readily secured in position on a lathe for holding work of various kinds. Patent 1530566. J. F. Lobbett, Middleport, N. Y.

Prime Movers and Their Accessories

TAKE-UP DEVICE.—For incorporation in a valve assembly to automatically provide for expansion and contraction, and eliminate flapping of the valves. Patent 1531909. H. H. Engemann, 3046 Hazelwood St., Detroit, Mich.

APPARATUS FOR BORING THE CONNECTING RODS AND BEARINGS OF INTERNAL COMBUSTION ENGINES.—Adapted to be used for the quick and adequate boring of the crossheads or big ends of connecting rods. Patent 1532914. M. K. Makarewiez, c/o C. Chassevent, 11 Boulevard de Magenta, Paris, France.

ROTARY VALVE.—Which will afford facilities for controlling the delivery of a combustion fluid charge to one or more cylinders of an engine. Patent 1532483. C. C. Foss and D. D. DeLoach, Savannah, Ga.

PACKING FOR ENGINE CRANK CASE.—Constructed from metal, and so positioned as to frictionally engage the removable portion of the crank case. Patent 1532933. V. W. Page, c/o Victor Page Motor Corp., Melrose Ave., Stamford, Conn.

FUEL VALVE.—Adapted to initially open for the ignition of a small portion of oil, then fully open to force the remainder into the cylinder. Patent 1532512. J. A. Murdock, 33 East 12th St., Tulsa, Okla.

SPARK PLUG.—Which is self-cleaning, maintains a predetermined spark gap, and will economize the consumption of gasoline. Patent 1533979. F. M. Euler, 755 Springfield Ave., Irvington, N. J.

INTERNAL COMBUSTION MOTOR.—To which a combustible charge and a charge of air are automatically supplied under pressure. Patent 1534951. F. Hiemer, 423 W. Trent St., Plainfield, N. J.

Pertaining to Vehicles

TRANSMISSION LOCK FOR MOTOR VEHICLES.—Easily applied to the ordinary type of transmission, and by means of which the vehicle cannot be driven or towed away. Patent 1530801. I. L. Akin, 1509 W. 29th St., Oklahoma City, Okla.

MULTIPLE-DISK BRAKE.—Readily accessible, and so disposed as to obviate braking strains on the universal joints of the propeller shaft. Patent 1531185. L. C. Huck and M. Twight, c/o H. C. Strotz, R. 710, 231 So. LaSalle St., Chicago, Ill.

COUPLING FOR AXLES.—For use on axles generally, causing the wheels to follow the same track. Patent 1529941. D. H. Bradley, Apartado 56, Parral, Chih, Mexico.

DIFFERENTIAL TRANSMISSION.—Rendering the differential gear self-locking irrespective of the direction of rotation of one wheel relative to the other. Patent 1529942. D. H. Bradley, Apartado 56, Parral, Chih, Mexico.

RESILIENT WHEEL.—Having a single resilient tread possessing the resiliency of a pneumatic tire, yet entirely puncture-proof. Patent 1531896. A. P. Aspin, 3255 E. 91st St., Chicago, Ill.

SPRING SUSPENSION FOR VEHICLES.—Which embodies means for resiliently supporting the frame or body from the axle without permitting sudden rebound. Patent 1531938. H. Hiden, Jr., Box 304, Birmingham, Ala.

AUTOMATIC GOVERNOR FOR THE BRAKES OF MOTOR AND RAILWAY WHEELS, AND OTHER ROTARY DEVICES.—Giving a maximum breaking action at high speed and preventing dangerous wedging of the wheels at reduced speed. Patent 1531926. P. Hallot, c/o Office Picard, 97 Rue St. Lazare, Paris, France.

ROUT INDICATOR FOR VEHICLES.—Operatively connected with the running gear for displaying names of stations along the route as they are reached. Patent 1532731. P. H. Coleman and F. W. Stout, Box 16, Lynch Mines, Ky.

DOOR CATCH.—Which can be utilized as a catch for a vehicle door, or for rigidly locking the door. Patent 1532322. J. H. Lane, Richfield, Idaho.

VARIABLE CAPACITY PUMP.—In the form of a hydraulic power transmission mechanism for self-propelled vehicles such as automobiles, motor trucks and tractors. Patent 1532735. E. B. Dickerson, Corpus Christi, Texas.

AUTOMOBILE BUMPER.—In which the parts are so formed and assembled that it will have maximum strength and durability. Patent 1534010. I. Feiner, 119 W. 52nd St., New York, N. Y.

COMBINATION WORKSTAND AND TURNTABLE.—Which is simple, readily interchangeable, easily knocked down, and available for any automobile owner in his private garage. Patent 1532728. F. J. Brobst, 126 East 29th St., North Portland, Oregon.

SANDING DEVICE FOR AUTOMOBILES.—Wherein a constant supply of air is provided for spraying the sand, as long as the engine is operating. Patent 1534239. L. Miller, 95 South 8th St., Brooklyn, N. Y.

MUD GUARD FOR MOTOR VEHICLES.—In the form of an apron, covering part of the lower portion of a wheel to prevent the splashing. Patent 1534922. E. F. Dauteuil, 17 Boulevard Felix-Faure, St. Denis, Seine, France.

LICENSE-PLATE HOLDER.—Adapted to secure any ordinary size or shape of plate, to any desired portion of an automobile. Patent 1534905. C. T. and A. C. Bowen, c/o Asa C. Bowen, 948 Selwin Road, Cleveland, Ohio.

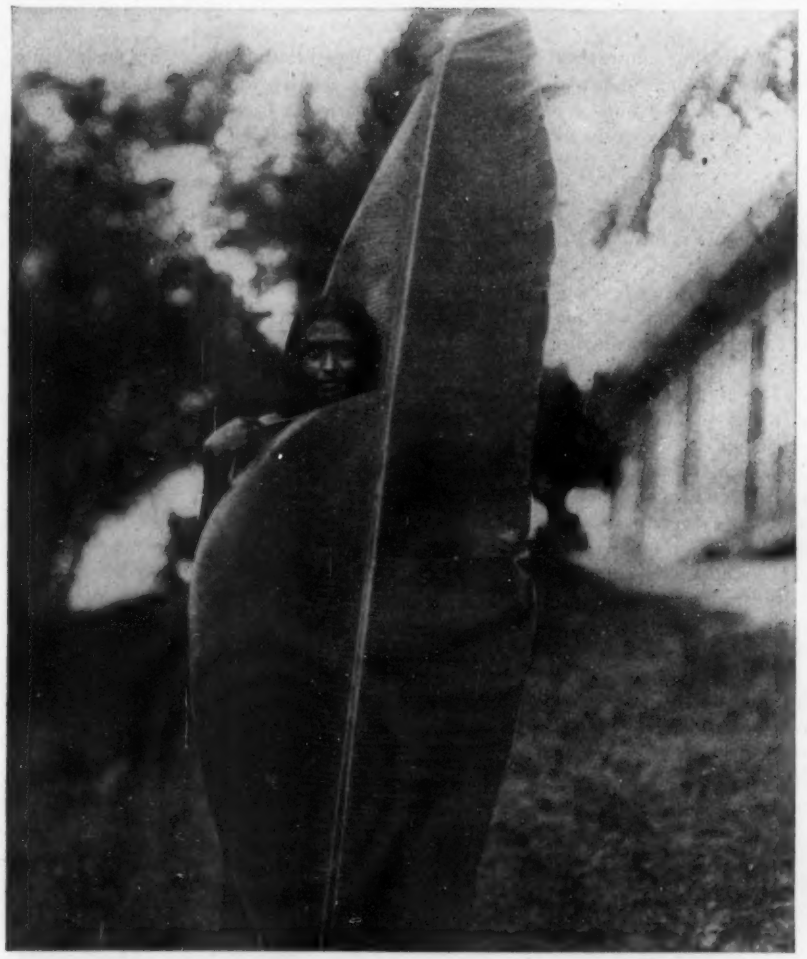
DEVICE FOR SECRET WRITING.—By means of which an owner, or insurance company may apply a secret identification character to any part of an automobile. Patent 1535,066. M. A. Vahjen, c/o Ernst, 316 E. 67th St., New York, N. Y.

Banana Land

Story in Pictures of One of the Chief Industries of the West Indies

Photographs by Thomas F. Lee

ONE of the largest industries of the West Indies is the raising of bananas. Close to 50 million stems of this fruit are shipped yearly to the United States alone. Eighteen months are required from the planting to the maturing of the fruit. Each day a cutter inspects his growing fruit and cuts such green bunches as seem sufficiently mature to warrant it. These bunches are then carried by pack mules to a pick-up train which runs through the plantations, and which carries the fruit to the steamers. Each car holds 500 bunches and 100 cars will supply the cargo for an average banana steamer.



A BANANA LAND EVE

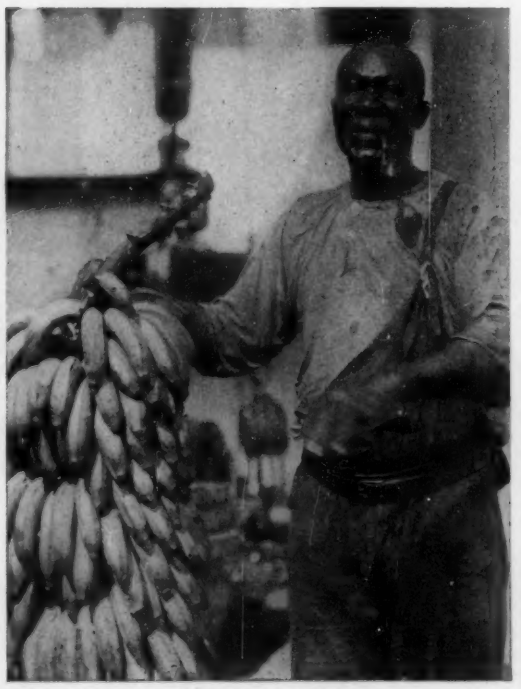
LEFT: *Perhaps after all the fig leaf did not constitute the principal item in Eve's wardrobe. The banana leaf may have furnished the essential garment. The leaf illustrated is an ordinary banana leaf cut in the heart of one of the plantations at Quirigua, Guatemala*

A NATIVE CUTTER

RIGHT: *A flat sharp knife is fitted to the end of a long slim pole—not for the purpose of cutting the fruit but for the purpose of hacking through the trunk of the tree below the bunch of fruit, thereby allowing it to swing down gently to the shoulder of the cutter*

EIGHTEEN MONTHS' GROWTH

In eighteen months a banana plant develops a stem larger than a man's body and matures a bunch of fruit. The above illustration shows the pithy character of the growth



A JAMAICA HERCULES

One of the loading crew on the deck of a banana steamer. He juggles hundred-pound bunches of fruit, smokes a business-like pipe and smiles continuously

THE "SHOULDER MAN"

This man carries the mature bunch of fruit from the place where it grew to the pack mule that is to carry the fruit to the pick-up train

The Wonderful Weaver of Webs

In the Air, Under Ground or in the Water the Artistic, But Unsentimental Spider Spins Her Snare

By Ewald Schild
of Vienna University

WHEN Kipling declared "the female of the species is more deadly than the male," he might well have been thinking of the spider. In the whole realm of nature there probably is no husband more afraid of his wife than is the spider spouse. Frequently the lady shows her disdain for the gentleman by killing and eating him.

Under the circumstances, the first approaches of the male spider to his lady love naturally are bashful. Often for hours he waits upon her doorstep before summoning up enough courage to enter her home. To attract her attention to the door, he timidly jerks the spoke-like threads of her many-sided structure.

Should his advances be scorned, he may, if he happens to be one of the jumping variety of spiders and, therefore, resplendently dressed, display his colored stripes, iridescent patches and plumes, like a strutting peacock. He goes through the most remarkable antics before her, just as roosters and pheasants display their attractions before their women folk.

Such is the courtship of the supreme artist of the animal world.

The Lady Sets Her Trap

We long have been accustomed to look upon the spider as a ruthless and cunning creature, inspiring in many of us a feeling of repulsion and even of fear. The truth of the matter is, however, that if we knew her better we could not help but admire her really wonderful traits—her patience, her industry, her resourcefulness, her skill. With the intricacy and beautiful craftsmanship of her web we are all familiar.

The family, or more scientifically, the order of spiders has representatives in all climates. One of the best known groups includes the web builders; it is found everywhere. On a twig or in the corner of the ceiling, the little weaver excretes through openings, almost microscopically small, in her weaving glands, a clear liquid which hardens at once when it comes in contact with the air, and so forms the familiar thread of the web. The glands from which is secreted the substance of which the web is spun are located in the spider's abdomen.

When the thread is long enough to swing in the wind it sticks to some other object in the vicinity, for it has not hardened too much as yet to lose its stickiness. Now the spider swings out into space, paying out her rope as she goes, until she lands on the spot she has chosen. Securely fastening the web, she climbs aloft again and repeats the process over and over again, thus forming the outer enclosure of her web.

Somewhere near the center of the framed space she attaches a little silk-like tuft. To this the diagonal or ray-like webs are to be fastened, forming a hub. Round and round she goes now with infinite patience, spinning the principal parts of the web until it is complete.

So the eight-legged lady builds the parlor into which she invites the fly to step. As an efficient animal trap it has never been excelled by anything any man has ever invented.

No Affection Wasted on Children

As a mother the spider shows no more sentiment than she does as a wife. She wastes no affection on her children. She does, however, give her eggs plenty of protection, literally building a wall around them. Perhaps you have seen little round or oblong clots, looking like dried mud or wax, clinging to blades of grass or stones along the roads, just as if they had been scattered there by a motor car as it splashed past.

Maybe they are mud. Just as likely as not, however, they are spiders' cocoons. Try cutting one of them open carefully with a knife. A silken cocoon may become apparent. In the center will be the spider's eggs, softly bedded and protected from prowling ants and grasshoppers by their hard casing. When one considers that these casings often are larger than the mother spider that builds them and that frequently they are completed in a single night, one is inclined to think that, after all, the reputation for doing all the hard work in the insect world shouldn't go to the ant.

An interesting type of web is the hemispherical one, resembling nothing so much as a canopied dance floor. Beautifully woven of sheer silk, with a tent-like net supported over a soft silken floor, and

TINY OGRES THAT TOIL NOT, THOUGH THEY SPIN

Most of the cannibal spiders are harmless to mankind. Spiders are not insects but they belong to the class known as the Arachnids, which also includes the scorpions, mites and ticks, and the king-crabs. Insects have six walking legs. Spiders have eight

STEP INTO MY PARLOR

Why does not the spider become entangled in its own snare? Nature provides it with feet that cannot catch

anchored securely to low twigs or grass blades, it is the home of one of the American spiders, a native of Texas. Begun in much the same way as the more common kind of web, it is given its dome shape and is drawn taut by strong threads leading to the twigs above. Above the tent is the spider's nursery, or rather incubator, where the tiny egg cocoons are stored.

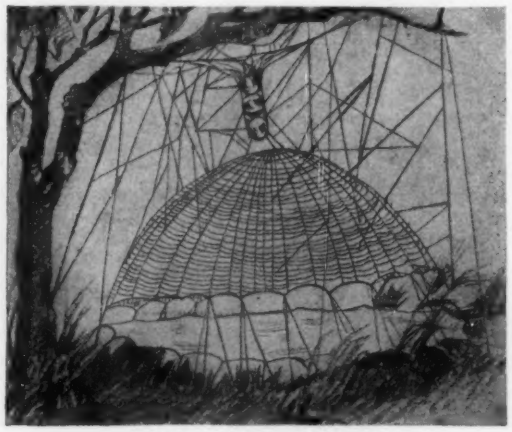
But the spiders are by no means all of them dwellers above ground. Some build marvelous tunnels or passages, closely woven and practically impenetrable to light. These tunnels attain a length of several inches. The owner usually rests near the entrance, out of sight. Woe to the poor bug led by fear of other enemies or prompted by mere curiosity to enter this dark cave. The waiting spider will make easy prey of her unsuspecting victim.

Originators of the Diving Bell

Other spiders are regular miners. They burrow in the ground, their finished homes generally being lined with a soft, fluffy silk. Some of them build a trap door to make the enclosure of their home complete.

Possibly the most interesting of all are the underwater spiders. Often they live in bogs and marshes. Long before man was man they invented the diving bell. The dome-like net, closely resembling a diving bell, is built near the bottom in shallow waters and is anchored solidly to some of the surrounding plants.

After the shell has been constructed painstakingly, the spider proceeds in a most remarkable manner to fill it with air. Her body is covered with numerous fuzzy hairs. When she arises to the surface of the water the spaces between these hairs dry out and become filled with air. Watch her closely when she dives again and you will see that she appears to be encased in a shining droplet like a gem. This is a quantity of air she is carrying down into the water with her, on the same principle as that of a fluffy cloth which, when you first immerse it in water, often carries air along in its strands and at first refuses to become wet.



LIKE A FAIRY BALLROOM

A Texas spider spins a dome-shaped web, like a parasol, held suspended by strong taut threads

A Submarine Nursery

When the diving spider reaches a position beneath the bell of her underwater dwelling, she shakes off this air. It rises quickly in the bell. This slow and laborious process is repeated again and again until the entire bell is filled with air, the water, of course, being expelled as the air accumulates. The comfortable home is now ready to serve as a trap for the unwary, as a storeroom for provisions against hard times and as a nursery for the water spider's numerous progeny.

Some of the spiders, on the other hand, fly aloft in balloons, so to speak, and drift for miles through the sunny air of the autumn days. One of these aeronautical spiders chooses some elevated spot, such as a stone, anchors herself firmly to the ground, elevates her spinners and proceeds to emit a continuous thread of silk into the breeze.

THE CAMOUFLAGED COCOON

One variety of spiders makes silken cocoons (left), and then encases them in mud (right)

When this waving kitestring reaches sufficient length the breeze exerts considerable tension on it and soon the spider lets go and is lifted into the air. Thus adrift, the little creature traverses many a mile of countryside until the breeze slackens and allows her to fall to earth again.

Sometimes, however, the breeze is too strong when first it is sent out. Then, instead of being blown aloft, the web is blown out parallel to the earth, striking the grass and failing to balloon. Some morning when you go out of the house before the dew has evaporated and find the ground bound by a vast network like gossamer, you will know that the ballooning spiders have just been trying by the millions to fly their kites, but that the wind was too strong for them and their kites fell to earth.

Thus we see that not all spiders are builders of the common flat, circular web, as many of us have believed. Some of them, indeed, build no webs of any kind, domed, submarine or otherwise bizarre. The hunting spiders, for example, earn their livelihood by running about and catching insects, here, there and everywhere. It is impossible for them to be tied down to constantly observing a snare for catching insects. Yet even these have homes, with only the web itself lacking.

Though in most cases the spider has eight pairs of eyes, yet she cannot see clearly more than a few inches. In this respect she differs radically from the bee whose different method of gaining a living requires both long and short vision, for bees must forage afar.

DIVING BELL OF THE UNDER-WATER SPIDERS

The daily supply of air is carried down in the dry spaces between the hairs on the spider's back

Most spiders are harmless; few of them are dangerously poisonous. All of the four hundred or five hundred species that a persistent seeker may find within easy reach of most American communities have poison glands, but none are as poisonous as they are reputed to be. Such poisons as they have are intended for defense against others in the spider's world of miniature life and for killing or rendering harmless the tiny creatures which supply her diet. Man's organism is so great that it will not succumb to this dose of poison that suffices to kill an insect.

Their Bite Not Dangerous

Though spider bites may be and often are painful, especially to certain individuals, they do not justify the fear many persons exhibit for the eight-legged creatures. The bites of a few species, nevertheless, do cause severe pain. The danger of their being inflicted, however, is offset to some extent by the color warning given to most of us by this class of animals. The more dangerous species display brilliant and sometimes very beautiful colors which at once attract attention; but of the ordinary little brown spiders which dart back and forth over our fields, busily engaged in their own business of building homes for their young and foraging for food with which to feed their infants, we need have no fear. Rather should we marvel at the intricacy with which their bodies have been fashioned and the diligence which they exercise in the use of the equipment with which Nature has supplied them.

A handsome slag-concrete bridge at Johnstown, Pennsylvania

Putting Slag to Work

A Newcomer in the Field of Concrete Construction

BLAST furnace slag, as indicated by its name, is produced, during the process of manufacturing pig iron, by bringing iron ore and a fluxing agent together in the presence of the intense heat generated in a blast furnace. The resultant product aside from the iron is essentially silicates of lime and alumina. It is just as essential that this material be disposed of in well-balanced furnace operation as it is to remove the resultant pig iron. Consequently the problem of moving, and if possible utilizing, the slag has within the past few years received a great deal of careful consideration.

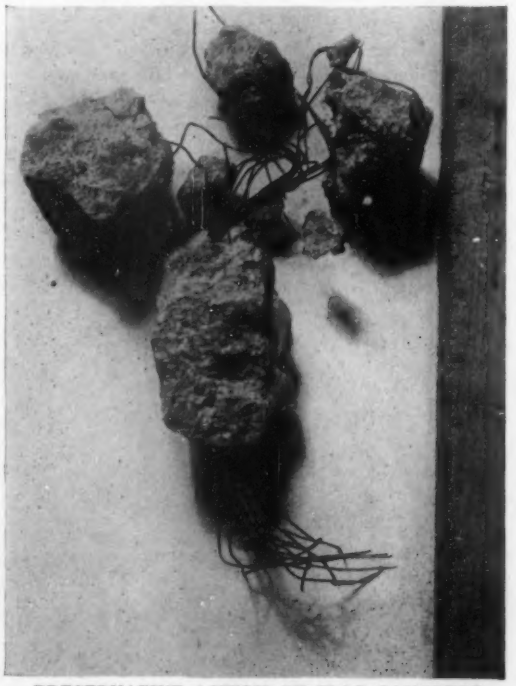
A SLAG PLANT

Locomotive crane stacking screened slag. In the background a crushing and screening plant

Up to fifteen years ago the methods were about evenly balanced between "granulation" and "bank" disposal. The former consisted of pouring the molten slag into huge concrete-lined tanks of water and chilling it suddenly. The resultant product resembles fine-grained popcorn. The "banked" slag was obtained by the use of a large acreage of plant property, over which the slag was poured in successive layers and allowed to cool more slowly. The material then is a lava-like mineral, structurally sound, absolutely uncontaminated by any matter that will not stand up under at least 3,500 degrees, Fahrenheit, and when manipulated by typical crushing and screening operations, breaks down into roughly cubical dimensions of rather large surface area on account of pits and projections on its faces.

In the typical pit system of disposal the slag is conveyed to relatively shallow concrete-walled twin pits, either by gravity or in huge ladles, and poured in super-imposed layers. As the succeeding layers are poured and cooled, well-defined lines of stratification, that are of great assistance in further manipulation, are developed. Each pit is designed to handle the product of its furnace for a period of from five to ten days. The modified pit system consists of long trenches in banks of slag already existing, generally in pairs, though in one plant the layout resembles a double race course.

Under the usual methods of commercial practice in a crushing and screening plant, the sizing can be most carefully controlled, so that the resultant product lends itself to most accurate gradation. The commercial or finished slag is light grey in color and in the sizes utilized for concrete and reinforced concrete (2 inches to ¼ inch and ¾ inch to ¼ inch) varies from sixty pounds to one hundred pounds per cubic foot. Larger sizes of the same slag run lower in weight. Except within very narrow range, at the present time the weight of slag cannot be controlled nor can the exact chemical constituents



PRESERVATIVE ACTION OF SLAG CONCRETE

Stovepipe wire intact after fourteen years' incorporation in reinforced concrete column

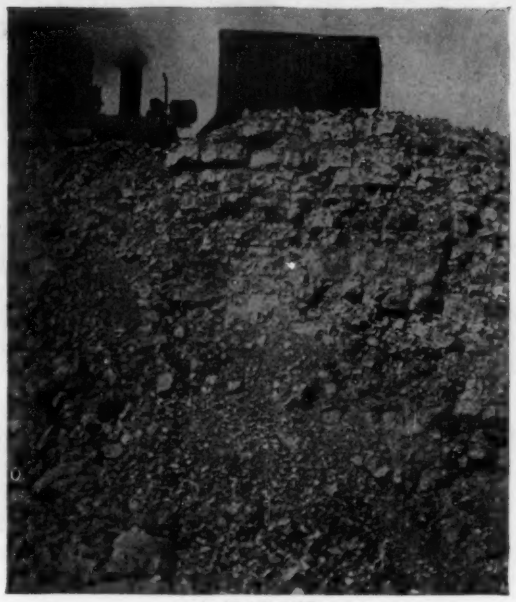
be anticipated. Each of these uncertainties is seemingly inconsequential. In service there has been nothing to indicate that furnace slag is anything but a chemically inert and very desirable, typical, mineral aggregate. Within the weight limitations named above, however, it has been proven by extensive laboratory tests that slag will produce concrete that is satisfactory for any type of structural design, or for any type of concrete used in highway construction.

The one greatest bugbear in the past that the producer faced was the fact that his material contained compounds of sulphur. In the earlier days of the art, the thought of "sulphur compounds" in contact with steel in reinforced concrete construction, was enough to send shivers down the spine of the designer. The findings of a committee in the American Society for Testing Materials, in 1923, which is composed of a number of the most prominent engineers in the country, resulted in their statement, in a note appended to the specification which admitted slag as an aggregate, that "No restriction has been placed upon the sulphur content of slag, for the reason that inspections made by members of the committee of reinforced slag concrete structures in the course of demolition, showed no signs of corrosion of reinforcement that could be attributed to slag, nor is there any published evidence that such corrosion has been observed so far as the committee is aware."

Slag Concrete Stands Severe Traffic Strain

Tests of slag concrete, made with slag as the large aggregate, have been carried out in several laboratories. The latest of the findings developed by the Test Section of the Bureau of Roads and presented by Raymond Harsch at the 1923 meeting of the American Society for Testing Materials, summed up this feature of the investigation as follows: "The physical properties of the slag, when tested by the usual rock tests, do not seem to be an important factor in determining the quality of the concrete made with slag as the coarse aggregate."

There still remained some doubt of the material's behavior in service conditions in concrete highway construction, because there was no clear-cut relationship between compression values and resistance to wear; but the past few years has brought about proof of the ability of the material to stand up under the most severe traffic punishment in sections of the country where the climatic conditions were exceptionally severe. There are approximately twenty million cubic yards of concrete and reinforced concrete in the United States in which the heavy aggregate is air-cooled blast furnace slag.



A SLAG PIT

This shows the stratified form assumed by a slag dump

The various sections of different types of highway construction in which slag has been used wholly or in part would total in excess of three thousand miles. Thirty-nine railway companies use the material in some division of their concrete construction and as ballast on their main and branch lines. Several municipalities have found by long-time usage that the material has given highly satisfactory results in their sewage disposal beds, and the great volume used, registered in square miles of specification roofing using slag, has never been estimated.

Slag and portland cement share the term "silicates of lime and alumina." The following table of figures representing the chemical analysis of nine slags and as many cements was made a few years ago during an investigation. Of the slags the figures given are for several hundred analyses.

	Blast Furnace Slag	*Portland Cement*
	Percent	*Percent*
Silica	32 to 35	20 to 25
Alumina	12 to 15	5 to 29
Iron	1 to 1.5	2 to 5
Lime	35 to 50	57 to 65
Magnesia	1 to 6	.065 to 3
Sulphur Compounds	1 to 1.75	1.25 to 1.75

In the process of manufacturing slag cement, granulated slag was dried completely and all free iron was removed by magnetic separators. The slag was then ground to cement fineness in a ball mill and varying proportions of hydrated lime was added to this product, and the two thoroughly intermingled by mechanical mixing. Slag cement distribution found its outlet in great measure through the construction operations of its producers, which were almost invariably composed of a group of the men connected with the blast furnace and steel plant. As a brick mortar its use was possibly the most popular, though mass concrete, supporting the huge machinery of steel plants and their shelters, consumed the bulk of the commodity.

As Good as Portland Cement

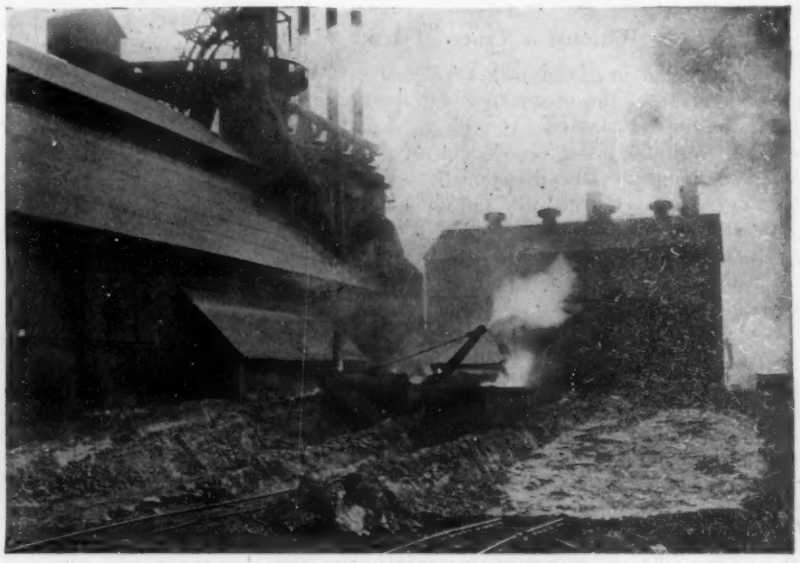
Erratic setting properties and the fact that slag cement concrete dusted, when exposed to the air, probably contributed more to its disuse than anything else. Recent examinations which have been made of old foundations which were made with slag cement and slag aggregates as well as other aggregates, and had performed their duty for periods up to twenty years, would indicate that in subgrade work slag cement would probably equal the portlands for all practical purposes.

Enormous volumes of granulated blast furnace slag are utilized in the manufacture of portland cement in this country. One of the largest producers of that commodity acknowledges its use, but the exact formula and representative figures of the tonnage of slag consumed are more or less industrial secrets. The cement turned out by one company passes all standard specification requirements satisfactorily, and long years of use has determined its permanency. It took many years of promotion, however, on the part of this organization to secure universal recognition of the fact that theirs was a true portland cement and that slag was but one of the raw ingredients, all of which, after being accurately proportioned, were clinkered and then ground to cement fineness. It is rather amusing to note that one of the chief objections to the use of this particular cement was the same as the promoters of slag as an aggregate for concrete and reinforced concrete have been facing for several years—namely, its sulphur content.

Prior to 1912, eastern cities, particularly Washington, D. C., New York, and Philadelphia laid hundreds of thousands of yards of slag block whose wearing qualities place it in a category of its own. Wear is practically nil. With the exception, in rare cases, of slight chipping at the joints, the effect of traffic abrasion on these blocks after twenty years' service is not measurable.

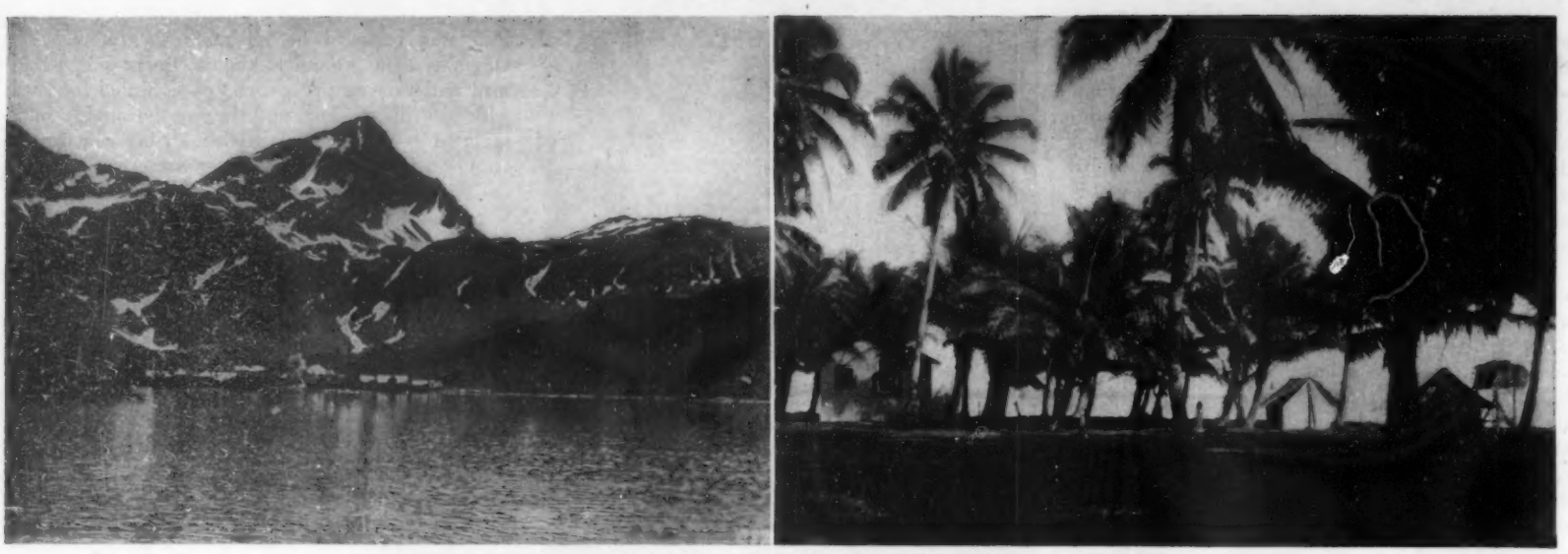
MODIFIED PIT SYSTEM

The bed of solidified slag is excavated and loaded into trains of cars



PIT OPERATION IN YOUNGSTOWN

Locomotive crane digging up the slag and loading it for transfer to the crushers



THE CARNEGIE TOUCHED THE EXTREMES OF CLIMATE IN HER CRUISE

Gytriken Harbor, South Georgia. Sir Ernest Shackleton's last resting place

Shore station at the Apia, Samoa. A magnetic and electric observatory is located here

Surveying the Oceans With the Non-Magnetic Yacht "Carnegie"

By J. P. Ault
Commander of the Carnegie

THE visitor to Washington who has chanced to drive around the speedway may have seen a sailing vessel or yacht berthed at the dock on the east side of Washington channel, completely enclosed with a canvas housing and easily identified by her two lofty masts towering 125 feet above the water. She is the non-magnetic, scientific research vessel, the Carnegie, resting from her cruises, famous as the only ship which has ever been constructed entirely of wood, brass and copper, all non-magnetic materials.

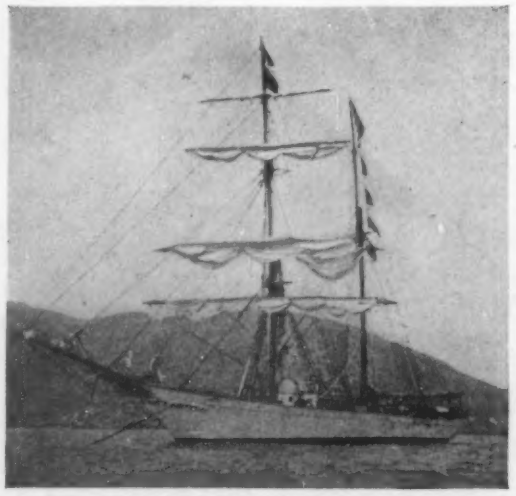
Since being launched in 1909 she has made six cruises, covering about 292,000 miles, extending from 80 degrees north latitude to 60 degrees south latitude, and has circumnavigated the globe three times. She is one of the very few vessels which has been as near as 600 miles to the true North Pole, and is the only ship to have circumnavigated the south polar regions in one season.

A Ship Without a Trace of Iron

The Carnegie has been making a magnetic and electric survey of the ocean areas for the Carnegie Institution of Washington. One of the departments of this institution, the department of Terrestrial Magnetism, (under whose direction the Carnegie has been operating,) is charged with the study and investigation of the earth's magnetism and related phenomena, and with seeking out the cause of the earth's magnetic and electric fields and the sources of the variations which are continually taking place. To this end, magnetic surveys have been conducted for a period of twenty years, not only of the land areas of the globe but of all the oceans as well.

The Carnegie was constructed in 1909, being built entirely of non-magnetic material. The timbers in her hull are fastened together with bronze spikes and bolts, the rigging is hemp instead of steel, the cook stoves are built of brass and copper, brick-lined, the anchors are bronze, each weighing 1,900 pounds, the anchor chains are not chains at all, but are manila rope hawsers eleven inches in circumference, and all metal fittings, davits and tackle are of bronze or copper. Thus no corrections on account of the presence of iron or other magnetic material need be applied to the results obtained with the various magnetic instruments used on board.

The following are some of the precautions necessary to avoid the accumulation of magnetic material on board. Brass screws must be substituted for the iron bolts in the chairs; the cooking utensils in the galleys must be of aluminum and copper; umbrellas and trunks must be stored aft, far removed from the magnetic instruments; the life-line gun and the projectiles, to be used in shooting a line ashore to save the crew in case the ship is wrecked, are made of bronze, and the cook has to keep his cleaver and meat saw aft among the engine tools. In fact, every bit of metal which comes on board is tested to find out whether it is magnetic or not by means of a small magnetized needle suspended on a silk fiber, a detective device which we have called "Sherlocke."



THE NON-MAGNETIC YACHT

The Carnegie at anchor in Camp Bay, Lyttleton Harbor, New Zealand

To prove that the Carnegie is actually non-magnetic we "swing ship," or make observations on different headings, and the results have always agreed within the error of observation.

The only iron or steel to be found on the Carnegie is that entering into certain parts of the auxiliary gasoline engine of 100 horsepower. But the total mass of magnetic material, consisting of pistons and rings, cams and cam-rollers, cylinder liners, and tools, is only about three percent of the total weight of the power plant; its distance from the nearest instrument used in the magnetic observations is such as to cause no effect. The observers on board cannot carry knives in their pockets, and even their belt buckles must be brass or copper.

Eleventh Century Navigators Used Magnetic Compass

The discovery of the lodestone, with its mysterious power of drawing unto itself all articles made of iron, paved the way to the invention and development of the magnetic compass, in use by navigators since the Eleventh Century. Voyages of discovery and exploration would never have been undertaken had it not been for the discovery and perfection of this magnetic compass. Even today the round-the-world Army flyers, and the Shenandoah, and Amundsen, in his attempt to fly across the North Pole have to depend upon this same magnetic needle as a guide in fog, in darkness, or over unmarked oceans and trackless icefields.

Since the earth is a magnet, the compass is directed unfailingly, be it night or day, cloudy or foggy. But since the poles of the earth-magnet are not quite at the geographical poles, and the lines of force do not exactly follow the meridians of longitude, it is necessary to map out the magnetic forces as they prevail over the oceans and to determine from time to time the progressive changes in these forces. Thus, if a ship sails from Vancouver to Japan, the compass at first points 20 degrees east of true north, being directed toward the north magnetic pole just north of Hudson Bay. This angle is called the magnetic

declination, and as the vessel sails westward this declination gradually decreases from 20 degrees east down to zero, and finally at Japan the compass points 5 degrees west of true north.

In order to sail a true course on any ocean the navigator must know how the compass points at all places. Hence the need for a magnetic survey of the oceans, and this survey must be repeated at intervals in order to keep the navigational charts correct and up to date. The progressive change with the years is not a steady change at any one place, nor is it the same for all parts of the globe. At London during a period of 232 years the compass changed its pointing from 11 degrees east of north to 24 degrees west of north, or a total change of 35 degrees. The largest change found by the Carnegie was in the middle of the Indian Ocean and amounted to 20 minutes per year, or over one-third of a degree.

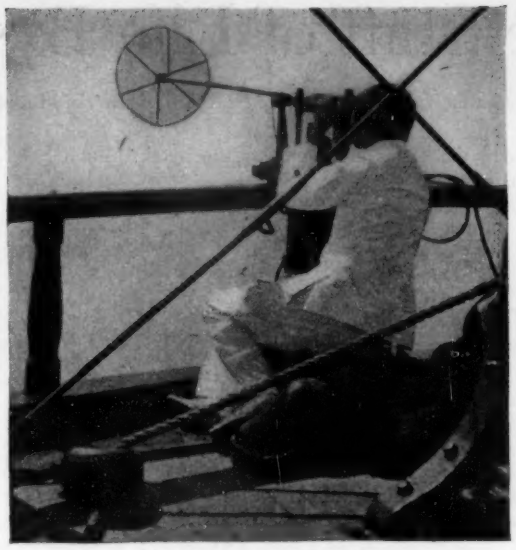
Magnetic Survey of Great Importance

The fact of the existence of the magnetic declination was emphasized first by Christopher Columbus in 1492 when his crew began to mutiny as the needle pointed more and more away from the direction of the pole star as they sailed westward toward America. Columbus quieted their anxiety by telling them that the compass was all right, but that the pole star had shifted in its position.

The results of a magnetic survey of the oceans are thus of great practical importance to the navigator; but they are of far greater importance to the student of terrestrial magnetism to assist in answering the questions which have been awaiting solution for several centuries—the cause of the earth's magnetic field, and of its daily and annual changes; the reason for the marked connection between the variations in the earth's magnetic field, on the one hand, and sunspot activity, displays of auroral or polar lights, changes in solar radiation, and ionization of the upper air by action of the sun, on the other hand.

The sun has a magnetic field similar to that of the earth, sunspots themselves are centers of powerful magnetic fields, and the years of greatest activity in the earth's magnetism follow very closely the years of maximum number of sunspots. We know that almost invariably we have a disturbance of the magnetic needle during a display of polar or auroral lights, whose beautiful undulating curtains and brilliant streamers of light we have all seen, even as far south as Washington.

Of interest to the radio audience is the fact that a study of the electric conditions of the atmosphere is a part of the daily and nightly program of ob-



"SOUNDING" THE AIR
Observing the atmospheric electric pressure or potential gradient on the Carnegie

servations on board the Carnegie. From these observations it was discovered for the first time that the electric pressure or potential in the air passes through its daily change from minimum to maximum simultaneously all over the globe, and not progressively with the sun as is the case with the daily fluctuations in many of nature's phenomena. As a result of these investigations we hope to shed some light on the fundamental causes of the electrical disturbances in the upper air and their consequent magnetic variations.

In literally sailing the seven seas the Carnegie has experienced all kinds of winds and weather, has visited most of the out-of-the-way islands of the ocean, and is better known the world over than any ship that sails the seas today. Observations are made every day regardless of storms or calms; but during all these experiences the vessel has suffered very little damage. She has been in danger several times, dragging her anchors in the harbors of Reykjavik, Iceland; Port Stanley, Falkland Islands; and Colon, Panama, but has managed to escape shipwreck.

During the circumnavigation of the south polar regions, December 5, 1915, to April 1, 1916, over 135 icebergs were sighted, averaging from 300 to 500 feet in height and one being five miles long—not comfortable sailing companions amidst the almost continuous fog and blizzards of the Southern Ocean. During the 118 days which this trip of 17,000 miles around the world occupied, we had gales on fifty-two days, half of them reaching hurricane force. This was the stormiest and roughest trip of all the Carnegie's cruises.

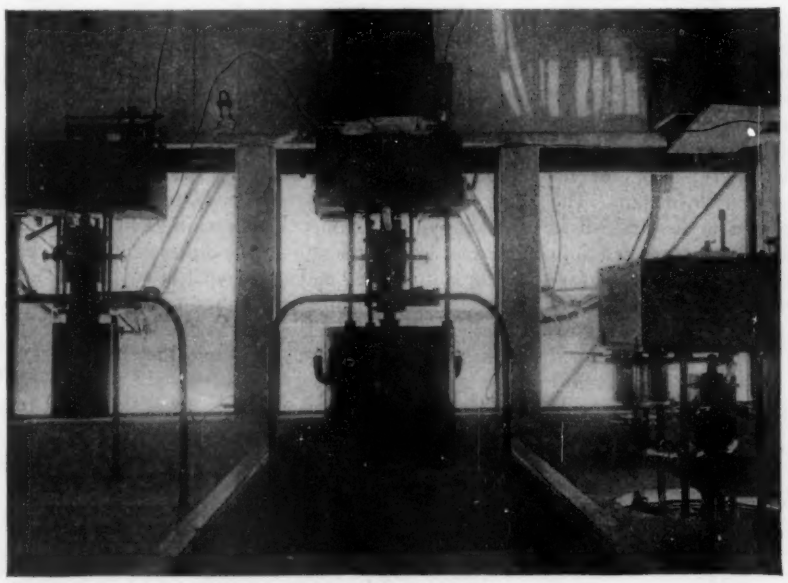
One of the most interesting islands we visited was Easter or Rapanui Island, fifty square miles of stone and lava in the South Pacific Ocean about 2,000 miles west of Valparaiso, Chile. It is famous for the hundreds of huge statues carved out of the mountain of volcanic lava and shaped after the human form. They average about twenty to thirty feet in height and are scattered over the island in all positions and places. Their origin is unknown, and the purpose they were to serve has been lost to view. Their unseeing eyes, somber, austere expressions and unsmiling lips give no hint of the secret which they have been guarding for centuries. The 200 natives are a curious mixture of Polynesian and white whalers and traders, and are about as far removed from contact with civilization as can be imagined.

South Georgia, Sir Ernest Shackleton's last resting place and one of the stormiest places of the oceans, was visited for two days during the subantarctic cruise. The wife of the Argentine meteorological observer was the only woman living on the island in the midst of 1,000 men engaged in the whaling industry. Derelict whales, which float about the harbor and come to rest on the strand beneath her parlor window, are poor substitutes for the roses and pansies beneath the windows of her more fortunate sisters farther north.

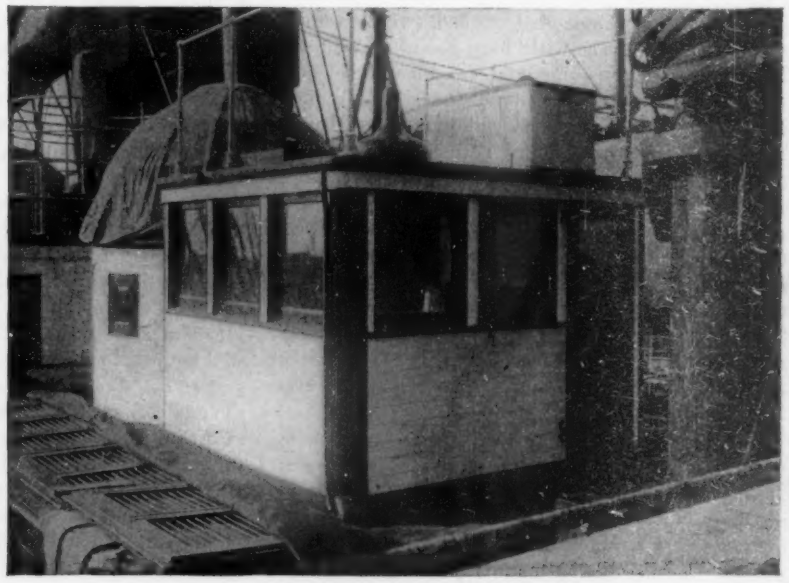
The Carnegie Helps Settle a Lawsuit

The practical side of our work was emphasized at Colombo. There was a case in court involving the location of a boundary line, and the claimant insisted that the line should be relocated according to the compass variation which existed when the first survey was made. The defendant argued that the compass variation had changed in the meantime. Since we were now repeating our observations at exactly the same spot in the observatory grounds at which we had observed nine years previously, we were called upon to furnish to the court the data showing the change which had taken place in the compass pointing during the intervening years.

The Carnegie has done much to fill the gap which existed in our knowledge of the magnetic and electric conditions which prevail over the great expense of ocean. We hope soon to send her out again to secure new data and to round out and make of permanent value the work she has already done.



THE OBSERVATORY
Interior of atmospheric electric observatory and instruments on the Carnegie



DECK VIEW OF THE CARNEGIE
Here we see the bridge and two of the observatories

Making the Staff of Life By Machinery

Photographs on the opposite page taken in the plant of the Ward Bread Company

WE probably never realized what a scarcity of bread meant until the war, when we were obliged to put up with wretched war bread which was poor in quality and abominable to the taste. We were glad to save the white flour for the soldier, but we ate the white bread with avidity when the necessity for economy was past.

Mechanical bread-making may not be as romantic as Mother's bread-making, but there are always advantages in quantity production, and it is the object of this article to show how our machine-made bread is made.

We notice that the bread we buy is sold wrapped in oiled paper, but as to the great story back of each loaf of bread, as to the science and organization and technical knowledge in today's chapter of the romantic history of the making of bread, most of us know very little.

Flour Submitted to Chemical Analysis

Today mills from all parts of the country send samples of their flour to the bakeries, which have corps of chemical experts devoted to exhaustive tests of each sample—as to moisture content, fineness of milling, bleaching, and amount and quality of gluten—that product in the flour which gives plasticity to the dough and which forms the framework of the baked loaf. From these tests the bakery of 1924 selects the flour which best meets the needs of the particular kind of bread to be made, and gives the mill which submitted the favored sample instructions to deliver a specified amount of unbleached flour showing a definite composition as to moisture, ash, gluten, acidity, color and fineness of milling of the flour.

Nor does this usually end the analysis of flour. The mill sends the bakery a tight container of every car of flour which is being shipped to it. These samples are then analyzed before the flour is delivered to the plant. After the flour arrives it is again checked by a laboratory analysis before it is used. In similar manner milk, sugar, yeast, shortening, salt and other ingredients are all purchased according to very careful specifications of quality and purity.

The Element of Luck Is Eliminated

The days of home-made bread, with Mother's anxious hope that she will "have good luck with this batch of bread" are going, and with them the element of luck. There is no question of "luck" in a modern bakery with a well-organized laboratory and baking experts. Results are known before the ingredients are even mixed.

"There are 92,000,000 yeast plants in a gram of dough," says the chief chemist of the Ward Bread Company. "By feeding to the yeast in the dough, food which contains the proper nutriments, we found that we could increase the number of these plants to 230,000,000 while the dough was rising. A much smaller quantity of yeast may thus be used to attain the same fermentation, and a lighter loaf of bread is the result."

We will start at the beginning of the mechanical process, in the great airy assembly room—not an auditorium, as its name might indicate. Here we see the raw materials "assembled" for a batch. The flour is in a large hopper, the water is in a huge suspended bucket. Both containers are equipped with electrically-controlled scales. On the truck is the yeast, the shortening, the salt, the condensed milk and the sugar sufficient for the batch. Each batch contains:

800	pounds	flour
470	"	water
13	"	salt
32	"	sugar
48	"	condensed milk
23	"	vegetable shortening
14	"	yeast

Making a total of 1,400 pounds

At the proper moment, when all the ingredients have been assembled and inspected, everything will be dropped through chutes into the mixer below, for everything, even dough, flows by gravity. To the rear will be noticed a trough filled with dough which the baker is about to pour through the trap door to a lower floor. The dough rises in well-ventilated and sunlit rooms and the carbon dioxide, produced by the yeast, is given plenty of opportunity to penetrate the batch evenly.

The huge dough-mixers, or dough-kneaders, are capable of mixing 1,400 pounds of dough at one time. There is nothing slow about them. They move at the rate of sixty revolutions a minute, to give thorough mixing and thorough aeration. During this process a continuous blast of cold washed air passes into the mixer, developing the gluten and cooling the dough, which would otherwise become too warm under the high-speed mixing. This thorough mixing aids in getting the dough into a mellow condition so that less fermentation is necessary. The dough stays from fifteen to twenty-five minutes in the mixer, depending on the type of bread to be made. Automatic stops are provided each machine so that all the batches will be mixed the same each time.

Machines Which Are Almost Human

A refrigerating and heating system in the dough room insures the temperature being at the same level day in, day out, winter and summer. Because the rising of dough is a biological process and a vigorous action results with increasing temperature and a slower action with a lower temperature, a definite control of temperature is imperative. In the dough room a system of humidifiers is also provided to keep the atmosphere saturated with humidity in order to offset the tendency of the mass of rising dough to lose moisture from its surface, due to evaporation. Uniformity of fermentation, of course, aids in obtaining general uniformity in the bread.

The risen dough is now on its journey to the oven and ultimately the table. Here begins the manipulation of the dough by a wonderful series of ingenious machines which are almost human. The dough in the hopper descends in a sheet which is then divided by huge machines and separated into units by the wire cage device shown in the engraving. This automatically cuts the descending dough into six pieces (all of the same weight), which we will not call loaves as yet. The machine was stopped just as the wires began to feed the six pieces toward the endless belt that is carrying the previously made masses of dough to the next machine. The capacity of the machine shown is 400 loaves a minute. A single one of these machines has scaled 100,000 loaves without interruption.

The scaled dough is now delivered automatically to the rotary turning-in machine, which molds the dough into a round mass and at the same time closes up the pores by putting a thin, dry film on the dough, preventing it from sticking to the boxes of the proofer into which it is automatically dropped. At the extreme left is shown the proofing cabinet, which consists of an endless series of boxes. Here the dough, through the effect of oxidation and loss of moisture, develops a soft outer skin, making it possible for the molding machine to mold the dough perfectly into the desired shape. Molding machines take the masses of dough and turn them into well-defined loaves ready for the oven. The masses of dough come from the proofing cabinet, where they were placed in fixed cups attached to endless belts, in gangs of six. The fixed cups discharge the half-formed mass on rapidly moving belts which take the mass and shape a "loaf" out of it, as shown by our inset engraving. The operation is very much like that used by boys in producing a roll of putty from the mass. The newly-formed loaf now drops into its pan and it goes to the steam proofer, where it remains in motion for forty-five minutes before it reaches the oven.

Five Thousand Loaves an Hour

The oven is about 115 feet long and is heated by gas. We present only a section of it so that some of the interesting details may be shown. Above will be seen the "steam proofer," which is imposed above the oven. Here the loaves in their pans, which are fastened together in gangs of four or more, move back and forth in a humidified atmosphere to allow the dough to expand. The dough finally reaches the bake oven, where it also travels automatically while it is being baked, as shown. This oven will bake 5,000 loaves an hour and the time of each loaf in the oven is about thirty-five minutes. The gas heating system is ingenious and is shown by the numerous tappings of the gas main. Over 4,000 cubic feet of gas an hour are required. Burners are at both top and bottom so as to bake the loaf evenly. The danger of gas explosives is eliminated by the device shown at the left, which takes care of any gas collected from leaky valves by making an electric spark at each gas main. The gas-fired oven is more easily controlled than the coal or coke oven, and so gives greater uniformity of bake, increased cleanliness and is economical as well.

More Sanitary Than Home Kitchens

The nice, crisp, well-browned and thoroughly baked bread emerges from the oven. The bread as it comes from the baking oven is automatically placed on these finger-like trays which travel back and forth in the glass-enclosed chamber. After the cooling and ventilating, which takes about one hour and thirty minutes, the bread is automatically taken from the racks and conveyed by means of traveling belts to the wrapping machine. This cooking and ventilating is a vast improvement over the old system of placing the bread on racks and allowing it to cool in a room unprotected from dust and other unfavorable influences. Even the kitchen cannot boast of such sanitary surroundings for handling the fresh baked bread.

The many wrapping machines wrap the bread before being delivered to the consumer in dustproof and germproof wrappers so that the customer receives the bread in perfect sanitary condition. The machine is very complicated and is almost human in the way it does things. Thus, for every new problem in the baking of bread, chemical research and mechanical science are finding solutions which a few years ago would have been believed impossible.

Bread Making on a Gigantic Scale

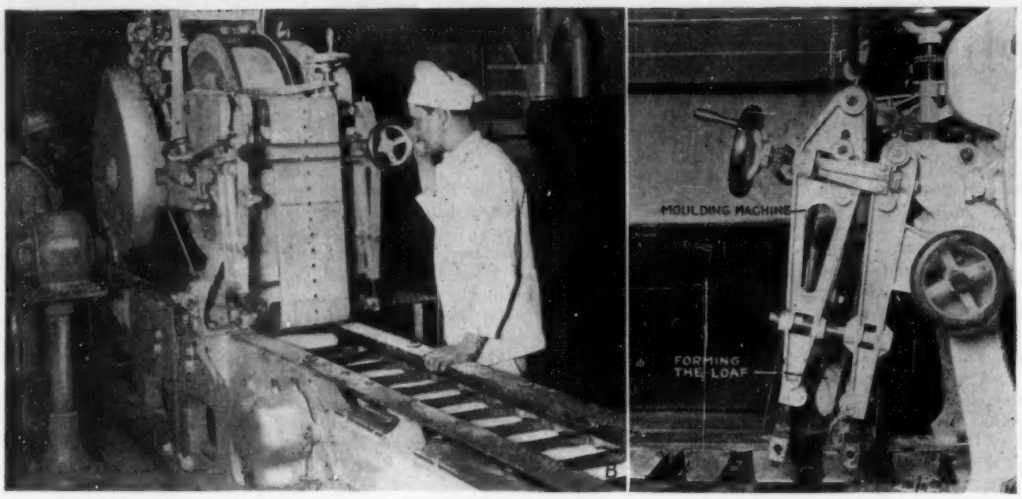


FIGURE 1

LOAF MOLDING MACHINE

FIGURE 1: *This is undoubtedly the most interesting process of bread making, for the weighed and shaped mass is formed into loaves between the endless belts and dropped into the pans "B"*

FIGURE 2

ASSEMBLING THE BATCH

FIGURE 2: *The flour, water, yeast, shortening, and so on, are all carefully weighed and drop by gravity to the dough mixer on the floor below. The quantity of these ingredients is given in the article*

MIXING THE DOUGH

FIGURE 3: *The dough is composed of the ingredients assembled above and mixed by power in the mixer, for from fifteen to twenty-five minutes. The dough is then emptied into large troughs for raising*

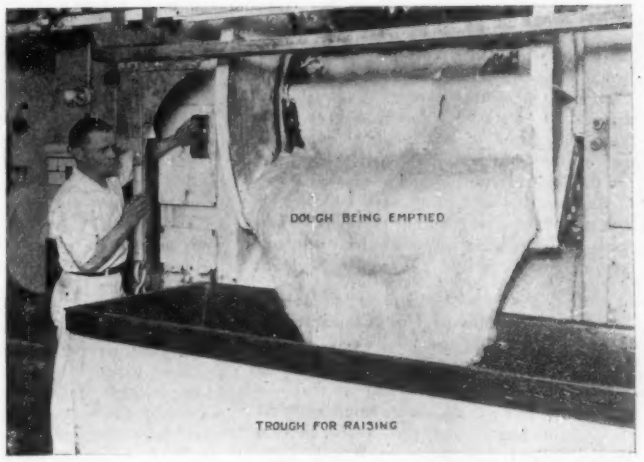


FIGURE 3

FIGURE 5

THE DOUGH DIVIDER

FIGURE 4: *The wire spiders cut the raised dough into shapeless masses of the same weight, with great speed and accuracy, and the dough is carried by endless belts to the next machine*

SHAPING THE LOAF

FIGURE 5: *An immense cone revolves and converts the unshaped mass of dough into something which resembles the loaf, but is not as shapely. The proofing cabinets make a soft outer skin capable of being molded by machine*

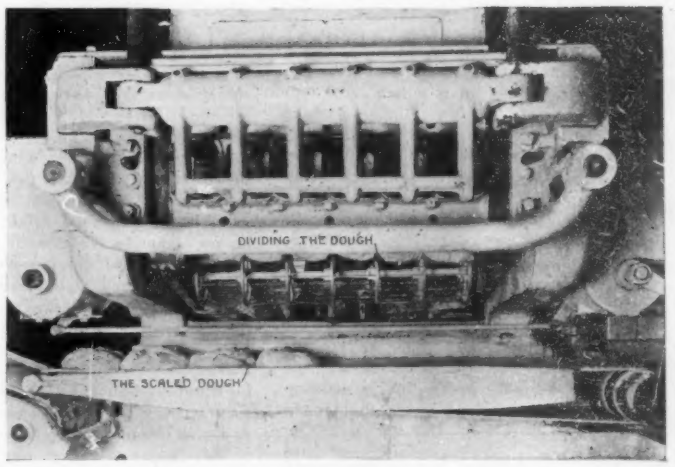


FIGURE 4

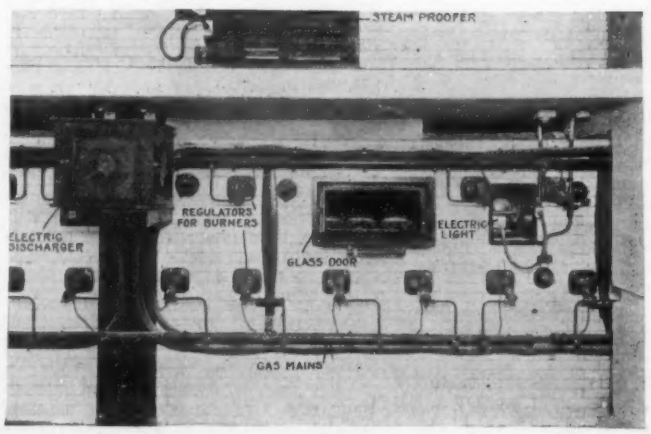


FIGURE 6

BAKING THE LOAVES

FIGURE 6: *The steam proofer which allows the dough to expand. The loaves then descend to the oven, which is heated by gas, and the loaves pass in procession past the glass windows. An electric discharger prevents gas explosions*

REMOVING LOAVES

FIGURE 7: *The oven is 115 feet long and at the lower end the baked loaves are removed from the pans and are sent to the cooler below, for warm bread should not be shipped.*

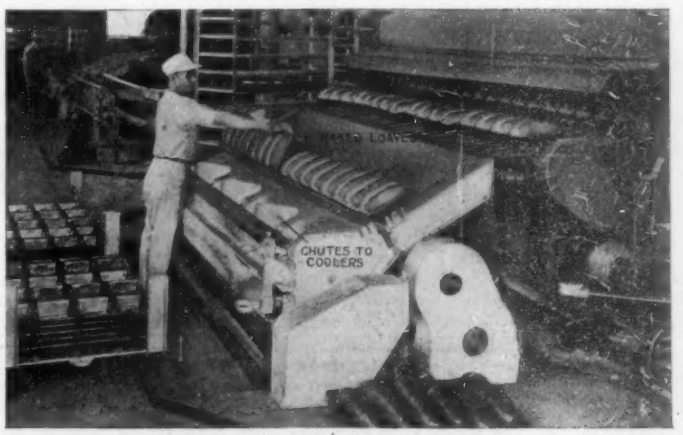


FIGURE 7

"Which Races Are Best?"

The Views of Some of Our Correspondents on This Much-discussed Article

IT has been suggested that our article with the caption noted above in the February issue be turned over to an open forum; and this is exactly what we are doing, except that the discussion has been carried on by mail. Objections came from the highest scientific circles and the bouquets from equally high circles. One letter in particular says we ought to give space to the "other side." As far as we are concerned facts are facts. We have no side and there is no "other side." We gladly give up the space to the views of a few correspondents who have avoided personal abuse and have stuck to what are facts or what have a reasonably good claim to be facts. Anyway, the article did precisely what a good leading article should do—it set people to thinking. It would be very poor journalism to ignore the humorous slant of many of the letters which would cheer up almost anyone even though they were in durance vile.

Well, let us start the forum with excerpts from the letter of the field secretary of one of the eternal committees which exist for the laudable purpose of moving and seconding motions and filing data and issuing reports of interest to the members. The letter is so decent in tone that we only wish the writer would allow us to mention his name.

Are We Bundles of Unit Characters

"Personally from what I know of the subject, and I am in a position to hear the inside of it, I really believe that the 'race superiority' talk is camouflage. At the recent meeting of the American Statistical Society, I heard a lot of such arguments and got real 'het up' over it. No, we aren't honestly trying to pass laws on the basis of race superiority. It is another reason altogether.

"Your article assumes that races blend. I think that any geneticist will tell you they cannot. A person is a bundle of unit characters, some or one for everything about the body. These are inherited intact. If a Jew marries a Nordic, the Jewish features would be lost, only to crop out when two persons marry who have a germinal make-up which will permit it. Many things are recessive. No doubt the different traits arose as mutations just as albinism sometimes appears. These changes are then inherited as such and *not blended*. Even skin color is not a blend. No sir, the human races are just as pure as are the breeds of dogs. Every breed of dog, no doubt has the other breeds in his make-up but he breeds true, and so do the human races.

"With the original experimentation I have done, I can almost make to order, any breed of dog from several others. I have a cross of a French bull that was mated with a St. Bernard, the two extremes, and the pup looks like a Beagle hound, exactly. But he isn't a breed nor a blend. If I mate him with his sister, I have a motley conglomeration of pups in size either like him, like the St. Bernard or like the French bull. The same thing happens when races of men are mixed, and the more distant, the worse will the results be. That is why two mulattoes marrying can have children all the way from pure white to coal black. In that case, I understand there are eight factors or units governing color.

"Another thing that the article apparently admits is the inheritance of Acquired Characters, which biologists disclaim.

"It seems to me that race mixture has ruined many races in the past from the little knowledge I have, whereas you state that it has not. As I look at it, no matter from where the races have come they have gradually been worked upon by the environment until they have become nicely adapted to it and have evolved their characteristic institution. So it goes."

A Good Bid for Space

So far so good. The next letter says "I think you are to be congratulated upon your ultra-progressiveness, and I wish you every success in your efforts to advance scientific knowledge." This is certainly a good bid for space and we gladly accord space to this electrical engineer who says:

"In your leading article for the February issue, I note that Mr. Hopkins states nobody knows why the skin color of various races changes with climate.

"For some time I have thought that this was caused by the action of the ultra-violet rays, and I wish to call the matter to your attention, as I feel that it is matter which deserves serious consideration." This hypothesis is probably wrong.

"No Strains of Pure Blood Left"

A correspondent from Omaha offers some food for thought. "My Idea Right or Wrong" seems to prevail in many letters in this controversy, if we can call it controversy. Here are Mr. D's remarks:

"The reason I was so gratified to read your article is because I had some controversy some years ago when the 'eugenics' fad was at its height. I wrote a letter to a prominent woman's magazine and stated my belief that eugenics would fail because there were no pure-blooded people to experiment with. I said we could raise pure-blooded cattle and horses, and other animals and fowls, but that we never could raise pure-blooded people. There was a storm of protest by the half wise and that class of chronic objectors who are so thick these days; and who practice the slogan 'My Country Right or Wrong,' except they substitute 'My Opinion Right or Wrong' or 'My Idea Right or Wrong.' I figured that if the races could blend and be assimilated as they were doing in this 'melting pot,' the United States, they could and must have done so in olden times. Therefore, there could be no strains of pure blood left; that we are the descendants of a mixture of peoples of the entire globe. Even if we admit the Adam and Eve story as an example, Cain went over into the land of Nod and got himself a wife. The blood was mixed right there.

"Even if eugenics would confine its efforts to healthy blood instead of pure blood to elevate the race, there would be difficulties, because for all we know there may be countless impurities in the human blood that science so far has no knowledge of, and that keep peeping out every so often. If this is not the case, where do the new forms of disease come from? The aristocracy of the old country and England has tried to confine itself to a more or less eugenic regime, but its offspring does not mount very high as monuments of eugenic perfection."

An Exponent of the Nordic Idea

A well-known scientist who is a great exponent of the Nordic idea says:

"The writer makes three statements: First, there is no such thing as a pure-bred race. This is incorrect. There are many such, in small groups in outlying parts of the world. Also in the larger continents we have groups of peoples showing a collection of characters which taken together constitute a race in the opinion of anthropologists.

"The second statement is to the effect that there is not one scrap of evidence to prove that any one race is potentially abler or more intelligent than another. To be sure we have five thousand years of recorded history in Africa during which time the Negro has been in contact with white civilization and the results speak for themselves. If this is not enough, we have the intelligence tests on Negroes and Whites taken in our draft army during the late war. These tests proved that there is a vast gulf between the average intelligence of the Whites and the average intelligence of the Blacks.

"The third statement is that racial mixture seems likely to be beneficial to civilization. The specialized characters of the higher races are relatively unstable and when these races are crossed with lower and more primtive races, the specializations of the higher races are lost.

"The three foregoing statements are scientifically incorrect and could only have emanated from an unintelligent acceptance of Professor Roland B. Dixon's recent book. This book has no scientific standing whatever and some of the conclusions, such as the existence of negroid elements in the original composition of the Nordic race are almost too grotesque to discuss.

"As an example of the inaccuracies in this paper, the statement that climate rules complexion has long since been discarded. Consider the Lapps, the Esquimaux, and the inhabitants of Northern Asia, all of whom are very dark in hair, eyes and complexion. In the next paragraph some of the historic statements are incorrect. For instance, the writer says that successive waves of Goths and Visi-Goths (the same people) came out of Asia. If the author had been familiar with the works of Jordanes and other classical authorities, he could easily have ascertained that the Goths came to the continent of Europe from the southern part of Sweden, a little before the beginning of our era, and settled in a place which still retains the name of Gothland."

Not in Favor of Mixing Races

One writer who holds an official position in Washington is very frank in his expression of his own beliefs and he objects to the mixing of races. He says:

1. "Such mixings produce every possible combination of the characteristics of the parent races. Of these combinations only a small part are an improvement on their parents. Therefore, if a race is already well adapted to the conditions under which it is living the extensive infusion of alien blood will make it less adapted.

2. "Man has the power to change his environment. For the conditions existing in this country prior to 1500 the Indian was the best. The white man changed the conditions and made the Indian a misfit. In the same way there is a strong tendency for the Jews and other non-Nordic immigrants to change this country so as to make the Nordics a misfit. If we let enough of them come in they will do just that.

"When we talk of the 'fitness' of a race we refer to its adaption to specific conditions. We cannot correctly speak of any race as being absolutely the 'best.' It is all a matter of opinion.

"I am a Nordic, and so I very naturally think the Nordic race is best. I appreciate that one who is not a Nordic may disagree with me, and that there is no possibility of reconciling this difference. But naturally I do not favor any change in the population of this country that will make it a less pleasant place for people of my race to live in.

"This is our country. We stole it from the Indians. If any other race wants it they have got to steal it from us."

"Not a Question of Racial Superiority"

One letter, very mild and dignified, brings forward an important point dealing with legislation concerning immigration.

"The new percentage limitation on the basis of the 1890 census was designed to do two things: (1) to limit the numbers of immigrants, and (2) to cut down the numbers of those coming from southeastern and southern Europe. This provision was intended to change the character of our immigration, and hence of our future population, by bringing about a preponderance of immigration of the stocks which originally settled this country. On the whole, there are few Americans who would deny that immigrants from Northern and Western Europe furnish us the best material for American citizenship and for the future upbuilding of the American people. They have higher living standards than the bulk of the immigrants from other lands, average higher in intelligence; are better educated; more skilled; and are, on the whole, better able to understand, appreciate and support our form of government.

"A percentage limitation based on the 1890 census is sound American policy, based on historical facts. *It is not here a question of racial superiority of Northwestern Europeans or of racial inferiority of Southeastern Europeans.* It is simply a question as to which of these two groups of aliens as a whole is best fitted by tradition, political background, customs, social organization, education and habits of thought to adjust itself to American institutions and to American economic and social conditions; to become, in short, an adaptable homogeneous and helpful element in our American national life. As President Coolidge tersely expressed it, "America must be kept American."

"We Must Restrict Immigration"

A prominent Army officer does not believe in the melting pot and expresses his views below:

"We got our ideas of the rights of man from the great Teutonic peoples. If blending were so good, why did not the same rights develop in that great blending pot, Asia? No, blending pulls down, never up. It was only when those early peoples, let them come from where they may, had migrated into the temperate climates of Europe, and there through age after age had developed in seclusion, that the opportunities and rights of man, as we conceive them, grew up. They have since been a beacon light for the world. The world is better in every way for their having lived.

"We, in America, must keep that beacon light burning. We must keep out of this country every possible element that would pull us down. We must restrict immigration to the point where we can easily assimilate those who may come, teach them our ideals of morals, religion, education; and then the nation will grow better and its people broader and better.

"I don't need to tell you that I am thoroughly out of accord with the article as written. From the scientific point of view, I can agree with the author when he concludes that modern peoples may have had one single ancestor and that all travelled from the place where this ancestor lived until they covered the whole earth, but when the author attempts to say that since all people came from a single tribe which scattered to different places and developed along different lines, that now if we throw them into a single pot and mix them up we will get a better race, then I disagree unalterably with him. The whole evolution of mankind differs with him."

Unfortunately, two of the most interesting papers which were presented at the Washington meeting of the American Association for the Advancement of Science dealt with this subject. The speakers spoke extemporaneously so we cannot quote their exact words but they gave the various elements which went into the English and the French peoples and the names were

remarkable. The English and French peoples are certainly a most complicated blend.

Questions Semitic Race

Another writer says:

"In your February article on Race and Immigration I find:

" 'Inside this (human) family it is possible to distinguish ten or fifteen groups which differ more or less from each other; The Negro, the Chinese, American Indian, the Jew, etc.'

"I am surprised to find the Jew classified along with the Negro and Chinese and other primary races, as if there were a distinct Jewish race. I had always understood that the Jews belonged to the Semitic branch of the Caucasian Race, Semitic because they happened to speak a Semitic language and not because they differed physically from other "Caucasians" for example, the Armenians, who are even classified as Aryans, because they happen to use an Aryan language."

We might reply to this as follows:

Here we might say that the criteria which distinguish one race from another are so indefinite and uncertain that it is practically impossible to say just what racial groups are to be considered as constituting specifically, 'Races,' and just what racial groups are to be considered as subraces or as branches of the larger race groups. With regard specifically to the Jews, it is our opinion that the physical, mental and other 'racial' differences are sufficient to justify the establishment of a definite Semitic race. The matter of language has nothing to do with it. There are many Jews, of course, who speak other than the Semitic languages, just as there are a few examples of other races who speak languages closely allied to Hebrew.

Now having given the "other side" the floor for the space of several columns, we think it wise to close the whole argument; but before doing so we intend to defend certain aspersions against the scientific status of our article which cannot be allowed to pass unchallenged. This article has produced a profound sensation. It has been copied and broadcast and has received warm expressions of approval. To be fair we have not attempted to bolster up our position on them, but rest our case on the broad foundation of a large anthropological literature—the product of as trained minds as those of any pro-Nordic sympathizer. Now to get down to cases:

Conclusions

The reason why races become dark in the tropics is not known with any great assurance but it is reasonably certain that this is not due simply to natural selection, that is, to the survival of the dark-skinned individuals rather than those of lighter skin. It is probable, although not proved, that *some* effect of climate tends toward the production of greater pigmentation in skin, eyes, and hair under tropic conditions than under the conditions of northern latitudes. This may be merely an effect of intense light or of intense ultra-violet radiation or both, but it is probably more complicated than this and involves temperature relations, moisture relations and the like. Comparatively little precise scientific work has been done on this subject and it is not possible to be dogmatic either for or against any of the views which have been proposed.

It has been suggested recently that the darkening effect of tropic climates may be a question of diet and due to more or less complicated combinations of stimulants and depressants, operating on the glandular system of the body. So far as we are aware this suggestion is, at present, no more than a suggestion. It does not seem to have been subjected to experimental test or to scientific criticism.

It is quite true that serious attention might properly be given to the hypothesis that ultra-violet light affects the skin color of the human animal, together with other bodily characteristics. But to determine this question would require a large amount of detailed experimentation, very little of which has been done as yet.

It appears to have been established by the physicians who are working with this subject, that the exposure of the skin to intense ultra-violet light produces an inflammation, and in the end, a killing of the skin cells. The familiar instance of this is sunburn.

Furthermore, there is good evidence for the idea that exposure to ultra-violet light stimulates the growth of the red-blood cells and the circulation of the blood, or, at least, the effectiveness of this circulation. It is entirely unknown, however, how these matters are brought about or what effects they may have upon such external bodily characteristics as the color of the skin or hair, the stature, the relative development of different parts of the skeleton and those analogous characteristics which we use as the criteria of race.

Practically Perfect Blending Exists

With regard to the statement that there are races which do not blend, this appears to involve the tacit assumption that human characteristics consist of so-called "unit characters" in the Mendelian sense. So far as we are now aware this is not the case. It is possible, of course, that certain elements of human difference will be found, on careful scientific study, to be unit characters and to be heritable as such, but there is no present reason to believe this. Within the extremes of body character now surviving in the human race, there seems to be a practically perfect blending and a perfectly complete variation bridging the gaps between all of the extremes.

There is a possible exception to this in the character of albinism but this character is a pathological one, due to the complete deficiency in that particular organism of the pigment-producing power. Even in this case, the behavior of this character according to Mendelian laws, in the human animal, has not been established with complete assurance.

Effect of the So-called Hormones

With regard to the inheritance of acquired characteristics, it is perfectly true that Mr. Hopkins's article admits this to be possible. This represents a viewpoint to which modern biologists are giving greater and greater adherence. It is true that for a time biology was dominated by the theories of Weismann. The result was the complete denial of any possibility of the inheritance of acquired characteristics. It was asserted and believed that the environment could not in any way effect the germ plasm. Lacking such an effect, the inheritance of acquired characteristics seemed physically impossible.

In contraversion of this viewpoint, one may adduce the large number of known instances in which the inheritance of acquired characteristics seem to occur. The force of this evidence was well understood by Darwin and the earlier naturalists. It has been obscured by the authority of the Weismann school.

Secondly, we now know (which Weismann did not) a mechanism by which the environment might become effective toward the germ plasm. This mechanism is the circulation in the blood of the so-called hormones, the products of the internal or endocrine glands. It is now established beyond much question that environmental conditions may affect the functioning of these endocrine glands and, accordingly, the relative quantities of the secretions of these organs in the blood stream. And since the blood stream constitutes, quite obviously, the environment of the germ plasm during its entire existence, it is immediately apparent that the quality and quantity of these hormone substances might become extremely effective in influencing the life, growth and proliferation of the germ-plasm units.

With regard to the statement that "race mixture has ruined many races" we are not aware of any instances concerning which this statement can be made with assurance. It is perfectly true that races have been mixed and have thereafter deteriorated. It is equally true that other races have been mixed, apparently with equal perfection, and have thereafter improved. Furthermore, it is well known that some races comparatively free from mixture with others have deteriorated and collapsed while others have improved and become more effective in the world.

All that this means, of course, is that we know nothing about it, one way or the other. If the argument be reduced to a balance of evidence, it must, of necessity, become statistical and we must inquire what proportion of thoroughly mixed races have increased and improved and what proportion have deteriorated and disappeared.

Complete data for such a statistical discussion of the subject is obviously unavailable, the degree of racial mixture in most of the ancient races being known only imperfectly, if at all. Nevertheless, so far as the evidence is available, it indicates that racial mixture has been, on the whole, stimulating and an incentive to increase and expansion, rather than the reverse. Specifically, the great bursts of civilizing activity on the part of Babylonia, Egypt, Greece and Rome followed in every instance the incursion of outside invaders of variant race, this invasion being accompanied, as was inevitable in ancient times, by a prompt and thoroughgoing racial interbreeding.

With regard to Professor Dixon's investigation of racial characteristics, it will be obvious on careful reading of Mr. Hopkins's article, that Mr. Hopkins does not adhere to all of the contentions of Professor Dixon's work. For example, it is one of the elements of Professor Dixon's conclusions that there existed at one time in the world a limited number (Professor Dixon says eight) of discrete races, characterized by specific combinations of skull-shapes and sizes. To this particular contention of Professor Dixon, we cannot agree. Disagreement must be recorded, also, with a number of additional contentions of Professor Dixon's work.

However, what Professor Dixon's data—by far the best assemblage of such data ever collected—does establish is that among all of the present so-called races of the world, there is substantial variation of skull character and substantial evidence of the previous admixture into these races of racial elements of different origin and character. In Mr. Hopkins's article, Professor Dixon's work was cited merely in support of this one contention, not at all in complete approval of all of its details.

Science Notes

The Chemical Composition of Tobacco Smoke

THE chemical composition of tobacco smoke may be ascertained by means of a piece of apparatus designed for this purpose, says *Kosmos*. This apparatus, devised by Thoms, consists of a glass cigar holder by means of which the cigar is smoked with the aid of a pneumatic pump, and of seven jars which collect the smoke.

Two of these jars contain a ten-percent solution of caustic soda, three contain ten-percent strength sulphuric acid, one contains defibrinated blood, and the largest is filled with dry wadding. The caustic soda combines with the acid component parts of the smoke, the sulphuric acid gathers the alkaline elements, the blood retains the carbon monoxide, and the wadding takes up the volatile empyreumatic oil.

Further chemical analysis reveals carbonic acid gas and water vapor, and a series of elements which, with almost no exceptions, are poisonous. These are nicotine, hydrocyanic acid, carbon monoxide, sulphuretted hydrogen, and pyridine bases.

The amount of the hydrocyanic acid compounds which pass into the smoke is so slight that no apparent harm results to the smoker. From each cigar about one thousandth of one gram of hydrocyanic acid enters the mouth-cavity. If the cigar burns out because of a strong current of air, less hydrocyanic acid is formed than when there is a lack of air and the cigar does not draw well.

The hydrocyanic acid compounds are probably formed by the decomposition at red-heat of the albuminoid substances in the tobacco. Carbon monoxide is the result of imperfect combustion of carburet, and one sixth of one percent of it is contained in the smoke which is inhaled. This amount, from a practical standpoint, is of no importance.

The amount of ammonium compounds in the tobacco smoke varies from 0.06 to 0.13 of one percent. Since the smoke which is exhaled is free from ammonia we know that the latter is entirely absorbed by the mucous membrane of the mouth. Ammonia causes irritation in the upper air-passages and it is also said to affect digestion.

About 0.015 to 0.02 percent of sulphuretted hydrogen is present, but this may be disregarded. The pyridine bases (0.3 to 0.8 percent) are apparently well received by the body, judging from the appearance of a pyridine-methyl-chloride compound in the urine. It has not yet been determined whether or not the pyridine bodies have an irritating effect on the nerves.

The characteristic effects of tobacco are essentially due to its nicotine, which varies in smoking tobacco, from 0.5 percent to more than 5 percent. The finer tobaccos contain from 1.5 to 2.5 percent of nicotine. Only a part of this nicotine is found in the smoke. Some of it is decomposed at the glowing point and is thus ineffective. In cigars, this is ten percent of the total amount. In cigarettes, it may be thirty percent. Another portion passes over into the vapor which escapes from the embers, and a large amount of the nicotine remains in the butt of the cigar or cigarette, where it probably forms a colloidal compound with albuminoid substances. In normal smoking, only one third of the total amount of nicotine of the cigar or cigarette enters the mouth.

* * *

New Methods for Handling Fruit Juices

MANY of the so-called fruit juices for sale at the soda fountains and soft-drink counters are composed of water and sugar with the addition of various flavoring and coloring substances. They are pleasing to the eye and agreeable to the palate, but they possess little or no food value and have practically none of the essential qualities of a natural fruit juice.

Natural fruit juice is very complex in its structure. In addition to the substances which give to it the characteristic flavor and aroma, various gums and gelatins are held in suspension. These constituents are difficult to remove although they make the juice turbid and uninviting in appearance.

For several years the Department of Agriculture has been investigating the problem of removing these objectionable elements from the unfermented juice without affecting its quality and color or impairing its taste. It is a problem with many angles.

To make its strongest appeal to the palate of the user, a fruit juice must contain, in addition to its characteristic flavor and fragrance, sugar, tannin and acid in a rather definite ratio. Not many fruits possess these constituents in the proper proportions, and to secure the desired result it is usually necessary to blend or mix the juice of two or more varieties.

By careful selection and combination the Department of Agriculture has succeeded in producing an apple juice which is perfectly transparent and of a beautiful color. It retains all the valuable properties of the juice, and will keep indefinitely without fermentation. It can be manufactured in large quantities with the certainty of securing a standard product.

Equal success has attended the experiments with grapejuice. By the process employed many varieties of grapes which have not heretofore been used on account of the unattractive appearance of the juice can now be made to yield a drink of the highest quality, both as to appearance and flavor.

The Scientific American Digest

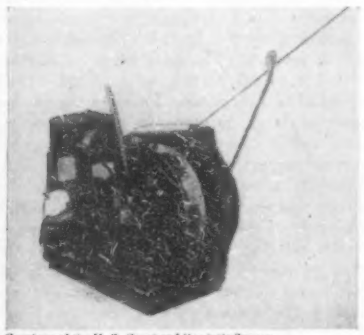
A Review of the Technical and Trade Press, Consisting of Abstracts from Leading Articles Announcing the Newest Developments in Industry and Engineering

Exact references to the sources from which these abstracts and quotations are made follow each abstract, the numerals referring respectively to the volume, number, and pages occupied by the original article in order that those who wish for further data may refer to the originals.
Other digests appear elsewhere in this issue

Conducted by Albert G. Ingalls

How the Depths of the Sea Are Probed

NEW electrically-driven sounding machines which have been perfected by the United States Coast and Geodetic Survey for the rapid determination of the depth of the ocean and the nature of its bed as well as of its water at various depths, are so efficient that a sounding three miles deep may now be taken in only one and one-half hours.



Courtesy of the U. S. Coast and Geodetic Survey

The newest electrically driven machine for sounding the ocean's depths

The new machine consists of a reel having a diameter of a little less than two feet, driven by a two-horsepower electric motor which obtains its supply of current from the ship's generator. On this reel is wound 4,000 fathoms or nearly five miles of standard, hard-drawn, steel piano-wire of No. 21 Brown and Sharpe gage. This size of wire is about half the diameter of the average pencil lead, yet it must be able to withstand a stress of one hundred pounds without breaking.

The use of such small wire as this has several advantages which may best be demonstrated by an account of the material formerly employed. Long ago, hemp rope was used. This was extremely clumsy when used for deep sounding. It was supplanted in 1872 by wire. Nevertheless the wire at first used had to be quite large in diameter, for it had to be strong enough to draw the sounding weight, some sixty pounds of metal, back to the surface against the water friction on thousands of feet of wire and of the weight itself.

Later, the detachable sinker was invented. Instead of pulling both wire and sinker up after the sounding had been made, the sinker automatically drops off when it strikes the bottom, a detaching device effecting this purpose very simply. The sinker is, of course, thrown away forever, but it has little value. The wire alone may then be drawn to the surface comparatively rapidly without danger of being broken.

The reel now used holds 24,000 feet of wire and when it is seen that each turn is wound on with a tension of one hundred pounds it is evident that the total compression on the drum, when all the wire has thus been wound up, is about 400 tons. Therefore, the reel must be of very sturdy construction. Its rim is five and one-half inches wide and three inches thick; of which a part must be cut away to permit of reeling the wire on it.

It is interesting to note that this cut for retaining the wire on the reel is only four inches wide by one and one-half inches deep; yet it suffices to hold the entire five miles of wire. This conveys an impression of the small size of the piano wire used.

In making a sounding to 18,000 feet depth, one-half hour is required for the descent of the sinker, and one hour for reeling in the wire. It has been found that the electrically driven machine reels in the wire about thirty percent faster than the older type of reel.

* * *

Helium Air for Submarine Divers

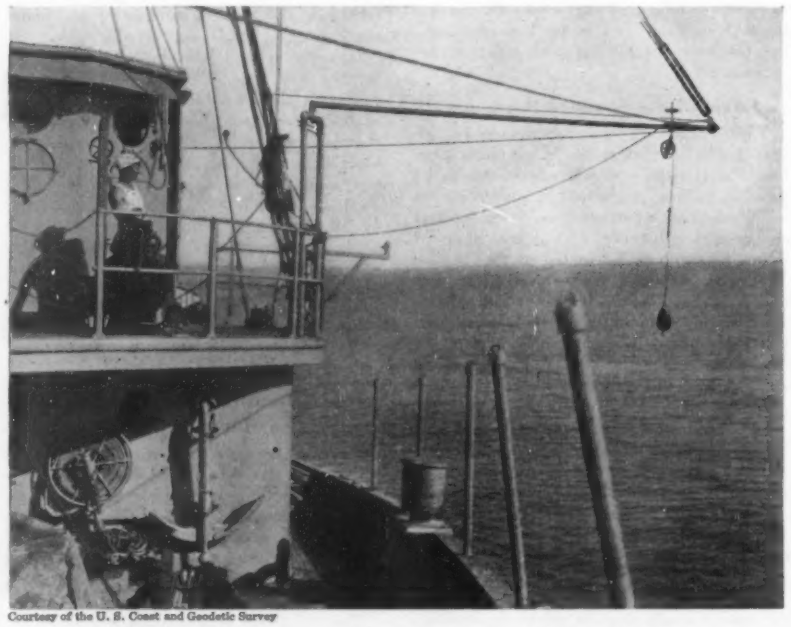
A NEW use has been found for helium, the gas with which our new dirigible airships, the *Shenandoah* and the *Los Angeles*, are inflated. Mixed with oxygen it forms an atmosphere suitable for workers in underwater caissons and for divers to breathe.

By using an atmosphere composed of oxygen and helium, instead of oxygen and nitrogen—the principal constituents of the air—it is hoped by scientists connected with the United States Bureau of Mines that the ailment common to those who work under high air pressure, known as the caisson disease, or "the bends," will be greatly reduced in prevalence.

The air we breathe is a mixture of oxygen and nitrogen, with several other gases in comparatively minute amounts that do not concern us here. As about four-fifths of the volume of the air is nitrogen the oxygen occupies only one-fifth of the total air space.

We breathe air because our bodies need its oxygen. The nitrogen is not used, but is breathed out again. It merely serves to dilute the oxygen. If we should breathe undiluted oxygen it would be disastrous to us. In a chemical sense, we would "burn up."

What the scientists at the United States Bureau of Mines have found out is that oxygen mixed with helium makes air as good for breathing as oxygen mixed with nitrogen; and that in addition it diffuses more rapidly in the body fluids and tissues as nitrogen, and that this results in the rapid elimination of the gas from the tissues during the decompression of the atmosphere in caissons.



Courtesy of the U. S. Coast and Geodetic Survey

Ready to make a sounding from the survey ship Blake

It is the decompression of the air in the caisson or in the diver's suit, rather than the compression, which frequently brings on an attack of the bends. A man can stand being placed in a caisson and subjected quite rapidly to air pressure rising to several times the pressure of the outside atmosphere. But if this pressure be brought back to normal very rapidly when his work in the caisson is through there is trouble. The man suffers an attack of caisson disease at once and this attack is extremely painful, causing him to wriggle and twist in an effort to clear his joints of the expanded air imprisoned within them.

Why this trouble arises is easily explained. When the pressure is first put on in the caisson the blood and tissues of the body absorb more and more air, in proportion to the degree of pressure. Since this absorbed air is also compressed, just as the body is, it causes no injury.

When, however, the air pressure is decreased this excess of absorbed air must escape from the body. If it could escape quickly it would do no harm; but it cannot. Instead, it lags in the tissues and joints and since the outside of the body is no longer under abnormal pressure the air imprisoned inside expands somewhat as the dissolved carbonic acid gas in a bottle of pop expands into bubbles when the cork is drawn and the pressure is thus released.

If, however, the air pressure be decreased very slowly, at the rate, for high pressures, of only about one pound per square inch per minute, attacks of the bends will be rare.

Naturally the necessity of bringing workmen out of high pressure caissons thus gradually takes up considerable valuable time and slows up work very greatly, making it more expensive.

In the same way a diver, after being exposed to the pressure of the water at the depth of 200 feet for three quarters of an hour, requires two hours for the ascent to the surface in order to avoid all danger of an attack of the bends. This time is wasted.

Helium has a lower coefficient of solubility in water than nitrogen and it diffuses more quickly. Therefore, less of it is absorbed, and that which is absorbed is more easily got rid of. It was therefore thought that helium might be used to good advantage for work in compressed air, whether for divers or in caissons. Scientists employed by the Government have therefore been making experiments on white rats and guinea pigs to determine whether this was so. The tests were carried out by Dr. R. R. Sayers, Chief Surgeon of the Bureau of Mines, W. P. Yant, Associate Chemist of the Bureau of Mines, and Professor J. H. Hildebrand of the University of California.

The animals were placed in a small pressure chamber having a thick glass window so that they could be observed while under pressure and especially during the decompression.

It was found as a result of these tests that with similar time taken for decompression of the helium-oxygen mixture the time of decompression could safely be decreased to about one-fourth that required for the nitrogen-oxygen mixture of ordinary air.

In order that helium may be used for rapid decompression in caisson and diving work it must first be made more available than it is at present. Large amounts of helium go annually to waste in natural gas, and it is not unlikely that steps to recover this waste will before long be instituted.—See *Serial* No. 2670, *U. S. Bureau of Mines*, February, 1925.

* * *

Americans Establish Traveling School for the Study of Prehistoric Man in Europe

AMERICANS who are sufficiently grounded in the study of prehistoric man and his evolution may now continue their work with a group of scientists who are to make, each summer, a complete canvass of the caves and other places in Europe where the remains of early man have been found. Instead of being forced to travel from place to place, making individual arrangements for excavating at the various sites where the implements and bones of prehistoric man are likely to be found, classes of advanced students will be conducted through England, France, Spain, Switzerland, Germany and

(*Continued on page 54*)

Courtesy of the United States Bureau of Mines

Observing a guinea pig under high pressure of a helium-oxygen atmosphere, through a thick glass window

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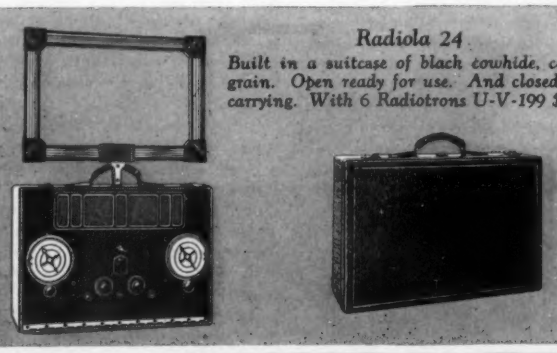

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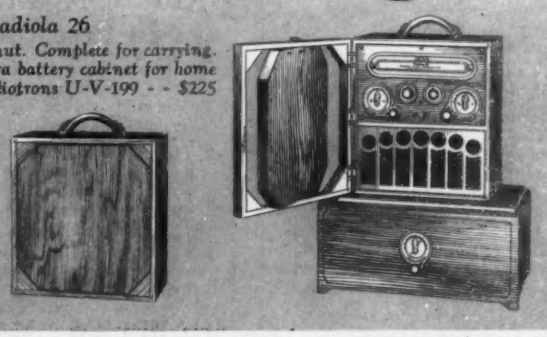

Who owns the telephone?

For seven carefree years young John Graves worked in the car shops at Orenville, spending his dollars as fast as he earned them. Soon after his promotion to foreman, he was married and moved to a little white house on Orchard Avenue. Life was happier than ever, but spare dollars were not more plentiful, especially after a third member was added to the family.

Then came a day when the plant superintendent showed John the wisdom of saving a part of his earnings, for the satisfaction it would bring, and for protection against emergencies and old age. He and his young wife, for the first time, learned the difficult art of economy, and finally they came to know the joys of saving and of safe investment.

Today John Graves, and many thousands like him, own the stock of the American Telephone and Telegraph Company. This company is owned by more people than any other, and the great majority of its owners—laborers, clerks, housewives, business men and others—have bought it with their savings. As its business has grown, the number of its shareholders has increased until now one out of every 45 telephone subscribers is also a stockholder.

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Belgium, for the purpose of excavating at various places under the guidance of a director.

The new method of pursuing anthropology by groups is employed by the *American School of Prehistoric Research in Europe*, and its director is Professor George Grant MacCurdy, of Yale University, an authority on anthropology and the author of a recent work entitled *Human Origins*, which summarizes what we know of man's prehistoric past from the beginning of the Glacial Period down to the days of the Romans.

This school, in which anthropology is studied directly from the actual evidences of early man, as well as from textbooks, is not a permanently located institution of the sort generally connoted by the word school; but rather it is a group of specialists or near-specialists in anthropology, traveling from place to place in a body, inspecting caves and studying the remarkable etchings left on their walls by races of men who lived at least twenty-five thousand years ago, digging for their skeletons and flint implements, visiting the various European natural history museums in which the most precious remains of early man are kept, and everywhere being accorded privileges which could be obtained by the individual student only with the greatest trouble. The traveling group method also makes possible personal acquaintance with foreign scientists of note.

Previous training in anthropology or closely allied subjects is a prerequisite for admission to the school, and it is therefore not simply a personally conducted tour for the dilettante. Last year the students, beginning work on July first and ending late in September, studied in twenty-three museums; visited and inspected fifty-five prehistoric sites representing every phase of prehistory; attended twenty-seven lectures by the Director and twenty-eight by foreign anthropologists; and excavated for twenty-three days at two of the most important sites in which the various evidences of ancient man have been brought to light from time to time.

France is the country in which the greatest quantity of evidence concerning prehistoric man has been found. The *American School of Prehistoric Research in Europe* therefore makes its headquarters in Paris, at the American University Union (173 Boulevard Saint-Germain); while the chief field work is done in southwestern France. In both of these regions there are many caves in the limestone in which ancient etchings of many varieties of animals have been found, together with stone implements made by the still more ancient Neanderthal race of sub-men about 50,000 years ago. These are the things the American group of scientists will study this summer.—*Art and Archaeology* (Washington, D. C.), vol. 19, pages 115-130 (March, 1925).

* * *

How Sap "Runs" in a Tree

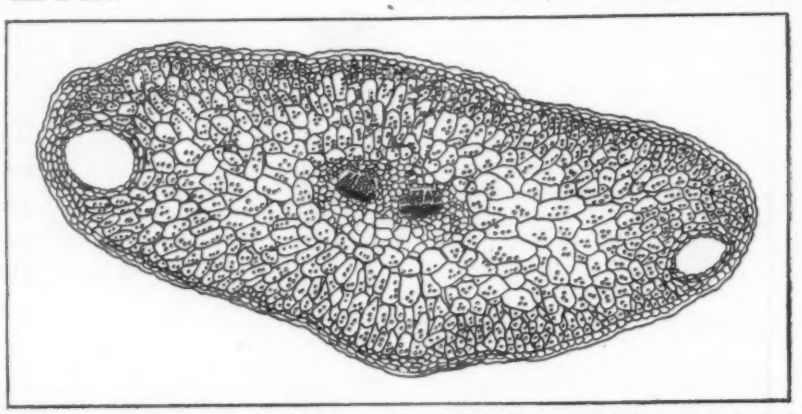
THE concentration of cell sap determines osmotic pressure, and this is the prime factor in the absorption of water by roots, and in its transmission through plants, according to C. F. Korstian, Associate Silviculturist, United States Forest Service (Appalachian Forest Experiment Station, Asheville, N. C.).

Osmosis is a process by which solutions of different density, when separated by a porous membrane, tend to mix and to attain the same degree of concentration by movement in both directions through a membrane. In osmosis, the stronger movement is, for a time, from the weaker to the stronger solution. Thus, if a bladder partly filled with a strong solution of common salt, is placed in a vessel of pure water or in a weak salt solution, the bladder will gradually fill and become greatly distended. If the walls are strong enough a pressure of many hundreds of pounds per square inch may be developed. This is an example of osmotic pressure. It is really due to the pulling power of the substance in the solution upon the water outside of the bladder. After some time, the weaker movement from within the bladder to the outside reduces the pressure; and finally a state of equilibrium is reached.

The cells of a root hair of a plant act in much the same way as the bladder just described. An important difference between osmosis as it occurs in inorganic or lifeless substances and in organic substances is that a living cell is lined with protoplasm, and protoplasm has a strong affinity for water. This affinity causes it to resist the outward movement of water from the cell.

In order to draw moisture from the soil, the root hair must contain a solution of higher concentration than the soil water contains. When the ground is wet, the soil solution is usually weak; but when the ground is dry, the solution may become so highly concentrated that the root cells cannot absorb it. This is especially the case if the soil contains large quantities of soluble salts.

Usually, however, the root cells are taking in water from the outside. This tends to weaken the solution within them; and these cells in turn give up water to adjoining cells containing a higher concentration of soil solution. Thus, water moves from cell to cell until it reaches a system of long, tubular cells or vessels through which it is forced, largely by osmotic pressure, up the stem.



Food factory and pumping terminus of a tree. Highly magnified cross-section of white fir leaf. Here water from the soil and carbon dioxide from the air are converted into starch and sugars under the influence of light

Starting from the other end of the system, the action is somewhat as follows: Leaf cells, by losing water or by manufacturing carbohydrates, increase the density of their sap. Immediately they draw upon neighboring cells containing a weaker solution, thus automatically increasing the concentration of the latter. These in turn draw on the cells beyond, and thus the osmotic equilibrium is upset all along the line.

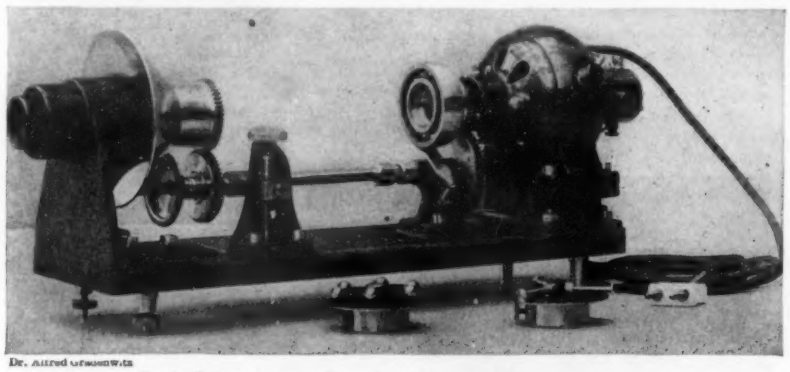
Korstian has determined the sap density, which is an index of osmotic pressure, in several hundred plants, including trees, shrubs and herbs in various vegetational zones at various altitudes above sea level. These determinations were made by the freezing-point depression method.

By this method the juice or sap is pressed from the leaves or stems to be tested and is placed in a glass tube which is imbedded in a mixture of ice and salt. The temperature at which sap freezes is determined by its density, and in saps containing a large

proportion of soluble matter, it is several degrees below the freezing point of water. The temperature at which freezing takes place is measured by means of Beckmann's thermometer, which registers to one thousandth of a degree, Centigrade. From the depression below the freezing point of pure water, the osmotic pressure may be calculated by means of mathematical formulae.

Sap densities are higher in the leaves than in the roots of the same plant; and they are higher at the top than at the base of the crown of a tall tree.

Sap density increases through the day, but decreases toward night. The minimum occurs in the morning. This indicates a relationship between sap density and photosynthesis, or the effect of sunlight on the building up of life compounds from inorganic matter in the green parts of plants. Doubtless, transpiration is also a factor. Shade plants have a lower concentration than sun plants of the same species. Young growing leaves and shoots have a lower sap density than older tissues. This explains why young shoots are most sensitive to frost.



Dr. Alfred Brauswitz

Optical instrument for showing rotating parts at rest

On a given site, the concentration of cell solutions varies from season to season. It is low in the spring, evidently because of abundant soil moisture and low temperature, with low rates of transpiration and photosynthesis. It is high in midsummer because the soil is relatively dry and because transpiration and photosynthesis are then proceeding at a rapid rate.

From these findings it is concluded that species of plants which are able to develop high osmotic pressure or sap density, at the same time maintaining a normal transpiration current, are better fitted to grow on a dry site than are species which are not capable of developing high osmotic pressure.

Plants growing on dry sites where the soil solution is highly concentrated must have a dense sap in order to draw sufficient moisture from the soil. Plants growing on moist sites, however, do not need a dense sap, because in such places water is more abundant, and the soil solution is relatively dilute. In afforestation the possibilities of various species on dry sites may be tested by comparing their normal range of osmotic pressure with that exhibited by plants on the ground.—*Journal of Agricultural Research* (Washington, D. C.), vol. 28, pages 845-907 (1924).

* * *

An Optical Instrument Showing Rotating Parts at Rest

A REMARKABLE optical instrument which causes objects rotating at any speed to appear at rest, has been produced in Germany. This is based on a novel principle and lends itself to a multitude of applications, mainly in connection with tests on rotating parts of too high numbers of turns to be followed by the eye.

It is well known that the reflected image of an object at rest is set rotating by causing the mirror to perform a rotation. Inversely, it is possible to cause a rotating object to appear as though at rest by reflecting it from a plane surface which passes through the axis of the rotating wheel—coinciding with the line of vision—and which round that axis performs a rotation at half the speed of the rotating wheel.

The illustration shows the general arrangement of the instrument, a ball bearing being chosen as object of demonstration.

The inside ball race of that bearing is tightly pressed on the axle of the motor, whereas the outside ball race, in opposition to the usual arrangement, is free to move. The spur wheel mounted on the motor axle reduces the rate of rotation in the ratio of 2:1, transmitting this rotation through the axle which has a steady rest, to the spur gears on the tail stock. These gears have the same numbers of teeth. The prism enclosed in the tail stock is thus seen to rotate at half the speed of the inside ball race of the bearing.

Looking through the prism in the tail stock, the optical effect makes the object appear at perfect rest, no matter whether the number of rotations is low or high, even at 10,000 r.p.m. Moreover, in the case of the ball bearing, the following secondary phenomenon is noted. Centrifugal force will carry along the balls mounted in the cage, causing them, the same as the outside ball race, to perform a relative motion. This, however, is so immaterial that the eye at any moment, will ascertain the amount by which the outside ball race seems to be in advance of the balls. In point of fact, it is actually behind by the same amount observed.

Inasmuch as it may be found of interest to ascertain the absolute speed at which the balls are turning round the motor axle, provision has been made for altering the number of turns of the prism by causing the rotating shaft, which has a universal joint, to be moved downward sufficiently to disengage the gears. The prism casing with the conical surface, is at this moment turned round by the friction disk in accordance with the actual position of the latter and rotated at variable speed, thus allowing the number of turns of the prism to be accurately adapted to that of the balls.

While rotating parts are thus brought to apparent rest, the ball race of the ball bearing, which is actually kept at rest, as well as the balls and ball casing, are seen apparently to rotate.

The impression thus produced is most striking. No matter at what number of turns the parts in question may be rotating, their image, as viewed through the prism, always seems to be at absolute rest. Any existing divergence in the ratio of transmission will at most result in slight fluctuation which, however, do not interfere with the fact that the prism enables the object in question to be seen distinctly with all details and accurate outlines.

The possibilities of application of this instrument are many. One of the most interesting is its use in testing objects submitted to centrifugal action. Prof. D. Thoma suggests its use in rendering visible the flow in a turbine. The turbine is for this purpose fitted with a horizontal shaft, a glass window being arranged centrally to the shaft and compressed air introduced through copper tubes at various points of the blade surface or the rotor canal, to render the flow visible. After issuing through fine holes, the air is carried along by the water in the form of minute bubbles.

Other applications are for ascertaining the number of turns of inaccessible shafts. The speed of rotation of the instrument being so adjusted as to cause the shaft to appear at

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rest, while the number of turns of the redressing prism is ascertained by means of a counter.

Telephoning X-ray Photographs

QUICK X-ray diagnoses by eminent surgeons and specialists have been made possible by telephoning X-ray photographs. Recently an X-ray photographic negative showing the bone structure of the human hand was sent from New York to Chicago in seven minutes. The details of the photograph were not lost in the procedure, and an accurate examination of the transmitted film was possible.

The time element in the diagnosis of an injury or ailment by a specialist is most important. In complicated fractures or other bone injuries, a quick diagnosis is invariably desirable in order to prevent infection or other complications.

During the tornado in the middle west early last spring a woman received a severe fracture of the knee. The medical men available, who were not X-ray specialists, were unable to treat her, and it was necessary to take her to New York. If an X-ray film could have been sent by wire, a specialist would have been able to reply immediately with instructions for preventing permanent lameness or other complications without the necessity of the patient going to New York. The possibility of sending the X-ray negatives by wire brings the specialist to the small community.

Courtesy of the General Electric Co.

An ordinary X-ray photograph taken in Chicago

Dr. D. W. Coolidge of the General Electric Company has already perfected a portable X-ray equipment which a doctor can use in almost any home by connecting it with the household electric lighting circuit. These outfits have eliminated the necessity of moving a patient to a hospital for X-ray examination. The more recently developed telephonic transmission of photographs indicates that soon it will not be necessary to take patients to large cities in order that the services of specialists be available.

"Medical consultation between doctors on X-ray plates transmitted by radio or telegraph is a realization that should find a most useful place in these progressive times," said Dr. J. M. Steiner, X-ray expert of Roosevelt Hospital, New York. "The quick transmission obtained by this method should afford untold satisfaction to both the consultant doctor and the anxious family. In New York hospitals, we frequently have patients who are either injured or taken ill while traveling. These patients, being in strange hands, naturally desire their home physician in consultation. If explicit information could be quickly transmitted to the home physician, much needless travel could be avoided, saving the home physician or family a trip to New York.

"Many times physicians in other cities, desiring an opinion from a New York consultant, could materially shorten a tedious delay if X-ray plates were quickly transmitted by telegraph to New York consultants, who in turn could render an opinion within an hour or two where otherwise several days to a week or more might be involved. Written descriptions or word pictures even of such simple conditions as fractures are often most misleading, whereas the actual conditions shown graphically in X-ray plates are more convincing."

Courtesy of the General Electric Co.

The same photograph as that at the left as it was received by wire in New York seven minutes later

Welcome Reform at the Patent Office

THE present Commissioner of Patents, Thomas E. Robertson, has been in office almost four years. He entered upon his duties at a time when conditions in the Patent Office were at a most critical stage. The receipt of applications for patent and trademarks jumped by leaps and bounds, the increases during the period immediately preceding and following Mr. Robertson's initiation into office being by far the greatest in the history of the Patent Office. The force of technical men, however, remained stationary and the turnover through resignations and replacements was at the rate of about 50 percent every two and a half years. It was a herculean job to take control at this critical period if the responsible functions of this important bureau were to be properly performed. The main line of attack was by legislative relief. Mr. Robertson, who is a man of affairs as well as a well known patent attorney, was peculiarly adapted for this special endeavor.

During his administration of the Office the Lampert Act was passed which reorganized the personnel of the Office, placed the technical man on a salary basis approximating the conditions in private life, and increased the force.

The net efforts of the Commissioner has resulted in a reduction of patent applications awaiting action from about 75,000 to 55,000 and has reduced the arrearage of work from an average of about nine months, to five months.

The most drastic changes in the technical operations of the Office have occurred in the trademark division. The increase of work in this division in recent years has been over one hundred percent.

For many years the quota of technical men employed by the Patent Office was never filled due to the inability to obtain recruits at the salary offered and also on account of the extremely high standard of the entrance examination. Exceptional efforts were made and were successful to arouse interest among the technical college students in the Patent Office as an introduction to a professional career, and in the last year about 200 passed the examination, and for the first time in many years there is a waiting list upon which to draw.

While the Patent Office has by no means reached that enviable position by which it can give the service that a highly industrialized nation should receive, it nevertheless has been improved so markedly the last few years as to warrant public appreciation. The improvement has been swift and thorough.

Learning to Use Our Wings

Aircraft are being put to use in peace as well as in war. This department will keep our readers informed of the latest facts about airships and airplanes

Conducted by Alexander Klemin

Associate Professor of Aeronautics, New York University

U. S. Army Air Service

U. S. Army Messenger plane which Lieutenant Clyde Finter successfully hooked and unhooked on airship TC2

Hooking Plane to Airship

THE military value of airships may be considerably increased if their tremendous load-carrying capacity and range can be utilized to transport planes over long distances to the scene of action. The Army Air Service experiments in this direction, therefore, have a practical as well as a spectacular value.

The apparatus involved is simplicity itself. The small Messenger airplane shown in the first of our photographs carries a metal hook attached to a frame over the center section of the plane. The airship carries a small trapeze, swinging from cables slung under the bombing rails of the airship (as shown in the second photograph), and extending about nine feet below the airship car.

Both hooking on and releasing the plane have been shown to be simple matters provided certain precautions are observed. In hooking on, the airship must be placed in equilibrium so that it does not rise or fall suddenly. Its speed must be at least five miles an hour faster than the stalling or minimum speed of the plane. The pilot of the airplane must keep the hook and trapeze bar in line. With these simple rules and reasonable skill, any plane can be hooked on to any airship.

The release of the plane is even simpler.

The Gas Turbine

THE gas turbine for airplane use has always fascinated inventors and designers. The Paris correspondent of The Scientific American now sends us news of such a turbine which appears to have solved the problem. It is the invention of M. Antoine Odier, an engineer sixty years of age, who has the personal distinction of being the tenth man to fly in an airplane and of having survived twenty-three crashes.

M. Odier has had the full support of the French under-secretary for Aeronautics. His seventeenth model has been tested by the French authorities and ran at 15,000 revolutions per minute for 200 hours without any perceptible wear.

The latest designs call for a turbine of 500 horsepower, to weigh only 670 pounds and to rotate at a speed of 9,200 r.p.m.

At the present moment the efficiency of an ordinary automobile engine is only 23 percent of the energy of the gasoline fuel. The Diesel engine, the most efficient prime mover in the world develops only 31 percent. For Odier's turbine an efficiency of 40 percent is claimed. It resembles the general construction of an ordinary turbine with blades rotating at a terrific speed within a stationary casing. Four explosion chambers are provided, in each of which there are

U. S. Army Air Service

Messenger plane, suspended from airship TC5, prior to being launched from it

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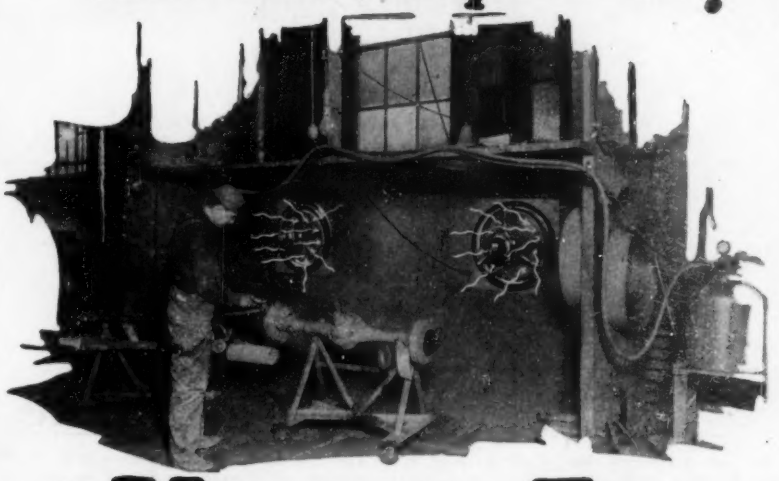

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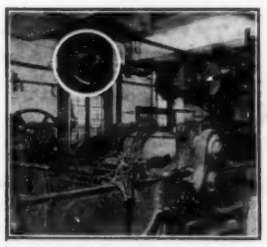
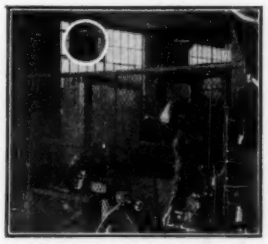
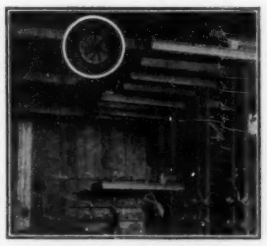


Ventura Fans will remove the dangerous fumes from pickling vats, paint rooms or smelters.



Poisonous gases that are found in all garages can be eliminated easily and quickly with American Blower Ventura Fans.



Men could not work in this core room if it were not for the American Blower Ventura Fan.

American Blower Ventura Fans for the removal of heat, gases and fumes are the most efficient disc fans on the market. They can be installed easily and quickly in any room or building having outside walls, windows or transoms. By removing dangerous fumes and foul, impure air Ventura Fans become important aids in increasing production and decreasing labor turnover.

If you have excessive heat conditions in your shop or factory, or are troubled with vapors, smoke, steam, fumes or poisonous gases, our engineers will gladly show you how easily and cheaply Ventura Fans will solve your difficulties.

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[452]

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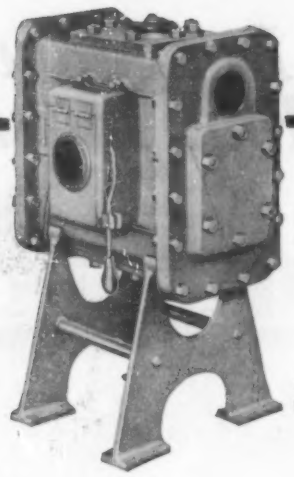

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2,200 explosions per minute, making a total of 8,800 explosions per minute.

Earlier designs of still greater rotational speeds produced a terrible roar, but the problem of silencing has now been solved. The lightness, compactness and steadiness of such a unit offer great advantages for airplane use.

We cannot accept these claims, however, without further details, and unfortunately secrecy has been imposed by the French Government so far.

There are certain inherent difficulties in the application of such an engine to aircraft use. The rotational speed is far too great for the propeller, and a gear reduction of at least 5 to 1 is necessary. Further, the gyroscopic effects are enormous at these tremendous rotational speeds and the aircraft pilot would have to be specially trained to overcome the gyroscopic forces resisting either turning or pitching of the aircraft.

The gas turbine itself presents extremely serious difficulties also, that makes us doubt whether the complete solution has been reached.

A recent paper before the American Society of Mechanical Engineers, by Marks and Danilov, presents an authoritative statement of these difficulties.

M. Odier claims a higher efficiency for his turbine than that of a reciprocating internal-combustion engine and this in agreement with common expectation, based on analogy with the steam turbine. Marks and Danilov dismiss this analogy as baseless. The higher efficiencies obtained with steam turbines result primarily from the use of higher superheats and lower condenser pressure than are possible with the reciprocating steam engine.

If a gas turbine were able to use higher pressures and temperatures than a reciprocating gas engine, the turbine would show similar superiority. But, owing to limitations of materials, it will have to operate at lower pressures and temperatures. In all probability, therefore, it will have a lower thermal efficiency.

This limitation in temperatures is due to the very practical difficulty that the exhaust gases impose their temperature on the turbine disks and blades, which are likewise subjected to very high mechanical stresses. All steels unfortunately lose half their tensile strength at 1,000 degrees, Fahrenheit. In Rateau's exhaust-gas turbine, tungsten tool steel stands up, however, to a temperature of 1,200 degrees, Fahrenheit.

Yet, while these learned authors point out very forcible objections in their analysis, they do not convince us entirely of impossibility. They themselves refer to possible advances in metallurgy which would raise the limit of permissible temperature, and they also mention such devices as steam jets or cooling air jets as available to reduce the working temperatures. At any rate, the subject is not closed. And perhaps M. Odier has something up his sleeve which will vanquish all the pessimistic theories.

Fat Men Penalized

DR. HUGO ECKENER, president of the famous Zeppelin works and pilot of the Los Angeles in her voyage from Friedrichshafen to Lakehurst brings sad tidings to fat men. In a paper recently presented to the Royal Aeronautical Society of London he estimates that passengers on airship lines of the future would be charged one pound sterling per pound of flesh for a transatlantic journey and heavy men would suffer accordingly.

Dr. Eckener analyzed a possible commercial service based on the regular transatlantic service of three large dirigibles. The approximate cost for each trip would be about $50,000, while the revenue from twenty-five to thirty passengers would be something like $80,000, from mails $15,000, and from baggage and express $20,000, leaving a neat profit for the operating company. The fare for each passenger would be about $700.

When once a feeling of safety had penetrated the traveling public, Dr. Eckener predicted a great scramble for bookings.

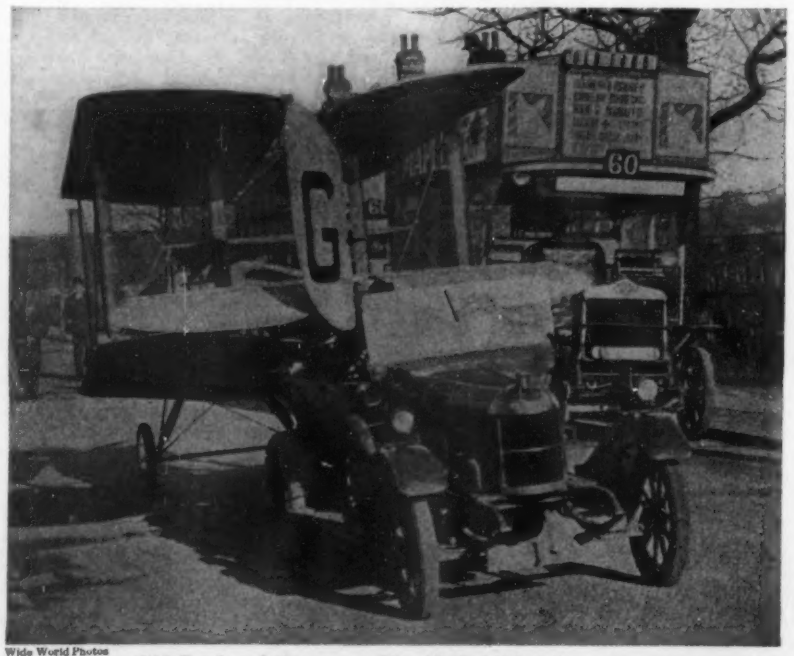
A Curious Game

FROM the Aero Club of Germany we have received particulars of a curious game "Das Weltflug-Spiel" — the World Flight Game. This consists of a huge map of the world with photographs of famous cities and other landmarks, and photographs of curious happenings in flight and on landing.

Six players are each equipped with dice and models of airplanes. By a special system of values each player proceeds round the globe experiencing all the good and bad fortune of the world fliers. Sometimes his throw enables him to cross an arm of the sea unperturbed, sometimes he is obliged to turn back by bad weather, or the lack of a good landing spot. A curious and instructive game for those interested in the vicissitudes of flying.

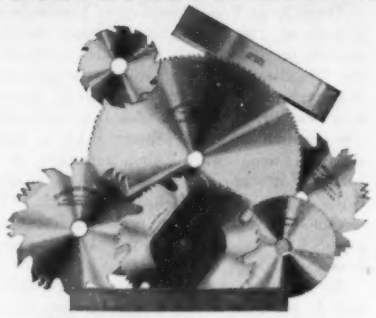
The Old Ford and the New

THE *London Aeroplane* publishes a curious photograph with the above caption. A lumbering London bus is seen traveling in the background to Old Ford, a suburb of the English capital. In the foreground the new De Havilland Moth low-power airplane, with its wings conveniently folded for transport is traveling on its own wheels to the airdrome with a small motor car providing the hauling power. A sight that may become very familiar.



Wide World Photos

Old Ford and the new. The Moth folded for transport



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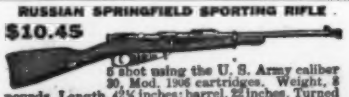

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As Fast as Sound

THE direct mounting of the airplane propeller on the engine crankshaft avoids the weight and power loss of the speed-reduction gear, and possesses other advantages which have made this form of drive very popular. The development of high-speed engines of large power using propellers of some ten feet in diameter at rotational speeds of 2,000 revolutions per minute and more has resulted, however, in giving the propeller tips enormous speeds, approaching those of sound (1,092 feet per second).

With these enormous tip speeds it has been found that the efficiency drops below the calculated values, based on the ordinary aerodynamic properties of the sections of the blade.

The question, therefore, as to the values of lift and drag of wing sections at these high speeds became of great importance to propeller designers. Accordingly the National Advisory Committee on Aeronautics in cooperation with the Bureau of Standards and the Ordnance Department of the United States Army undertook an investigation of the air forces present at these high speeds. The ordinary wind tunnel became impracicable. To secure these high speeds in a wind tunnel would necessitate fantastic horsepower, running into tens of thousands, with a cost beyond the power of even the United States Government to meet. For this reason a special apparatus was designed and set up at the General Electric Company's works at Lynn, Massachusetts.

A three-stage centrifugal compressor of 5,000 horsepower was employed, capable of delivering 50,000 cubic feet or more of air per minute into a vertical stand pipe, 30 inches in diameter and 30 feet high, ending in a cylindrical orifice 12.24 inches in diameter. Through this nozzle the air was forced to flow at speeds reaching 900 feet a second. The metal airfoils, exact reproductions of those used in propeller design, were held in the air stream and forces, both lift and drag, were recorded on a specially designed balance, with Bourdon gages as the measuring elements.

It was found that at speeds above .8 of the speed of sound, something like 880 feet per second, the lift of an airfoil dropped off sharply, while the drag increased. Translated into terms of propeller design, this means that if the tip speed is too great the thrust of the propeller will drop off and the power required to turn it will increase. A definite limitation is thus imposed on the speed at which airplane propellers may be run.

Is Flying a Profession?

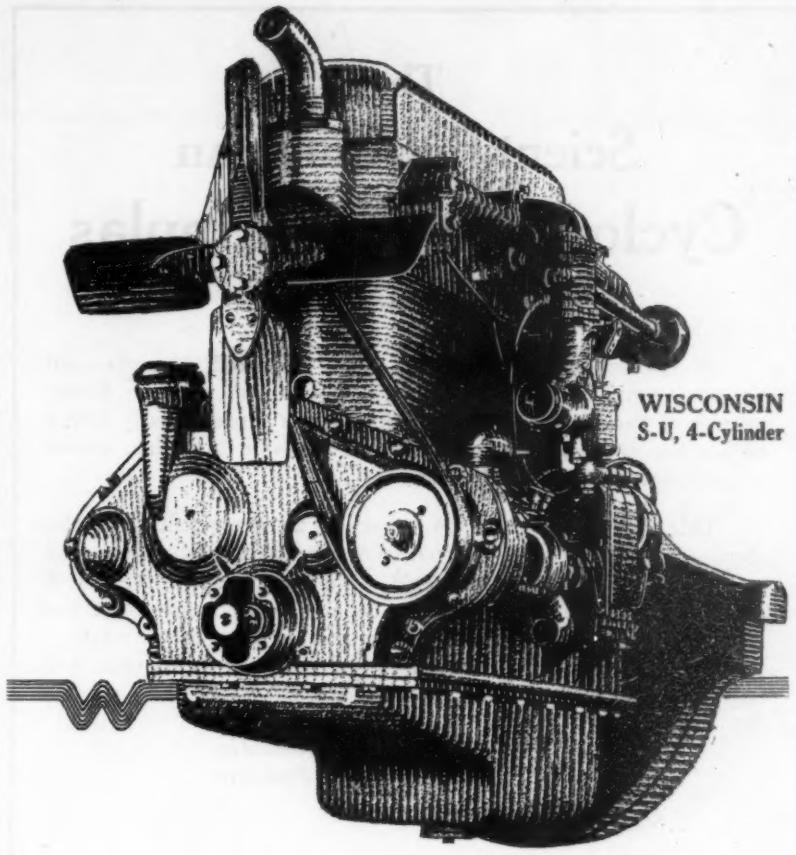
YOUNG men of good education who look with longing at ships flying high in the air, often ask whether flying is a profession. It would appear from the 1924 Canadian Report on Civil Aviation that it is. At any rate, the Air Board of Canada has taken the wise stand of giving licenses to pilots and requiring certain definite qualifications.

Airplane pilots are sub-divided into private and commercial pilots, the former not authorized to fly for hire. Each class is again sub-divided into three classes, planes of 1,000 pounds or less, planes of 3,000 pounds or less, and heavy planes of over 3,000 pounds.

All classes of pilots are required to pass an examination on the construction, maintenance and functions of the aircraft, its engine and accessories. They must have a knowledge as to rules of lights and signals, rules of the air and the conduct of traffic in the vicinity of airports, map reading, orientation, and elementary meteorology. They must pass a medical examination and be tested in a cross-country flight of 175 miles as well as in a night flight.

Similar certificates are granted to ground personnel, termed air engineers on whom is thrown the heavy responsibility of maintaining planes in an airworthy condition.

In practise this licensing of pilots and ground engineers has proved eminently successful with a decrease in the number of accidents.



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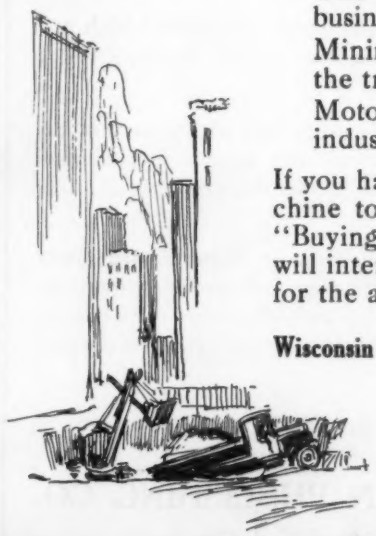
Wisconsin "X", 4-cylinder, 4½" x 5"; peak horsepower, 67 at 2000 R.P.M.

Wisconsin "W", 4-cylinder, 4⅛" x 5"; peak horsepower, 53 at 2000 R.P.M.

Wisconsin "S-U", 4-cylinder, 4" x 5"; peak horsepower, 50 at 2000 R.P.M.



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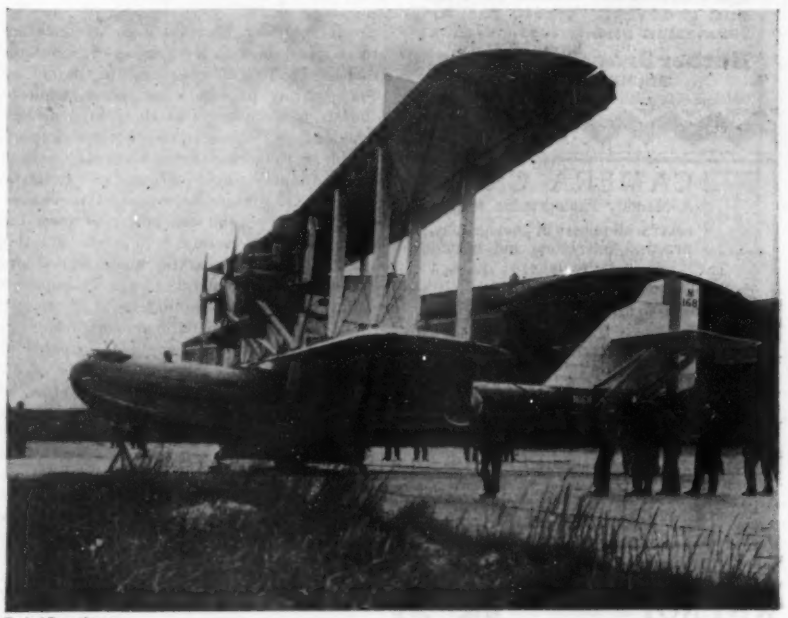
It is quite clear that some such system of licensing will inevitably be followed in the United States and will bring into being a valuable professional class of pilots and maintenance engineers.

Making a Seaplane Self-contained

A SEAPLANE, whether a flying boat or a hydro-airplane, is generally regarded as primarily a flying machine capable of alighting on the water, yet spending most of its time in the air and not in the water, and with its air characteristics of predominating importance.

According to Air Commodore C. R. Samson of the British Navy, who recently read a paper before the Royal Aeronautical Society, the position should be reversed. The seaplane should be a seaworthy boat that flies. It should be entirely self-contained; the crew should be able to live in the boats; and, once a day is set to go anywhere, the boat should start regardless of weather.



Topical Press Agency

The world's largest flying boat launched at Lytham

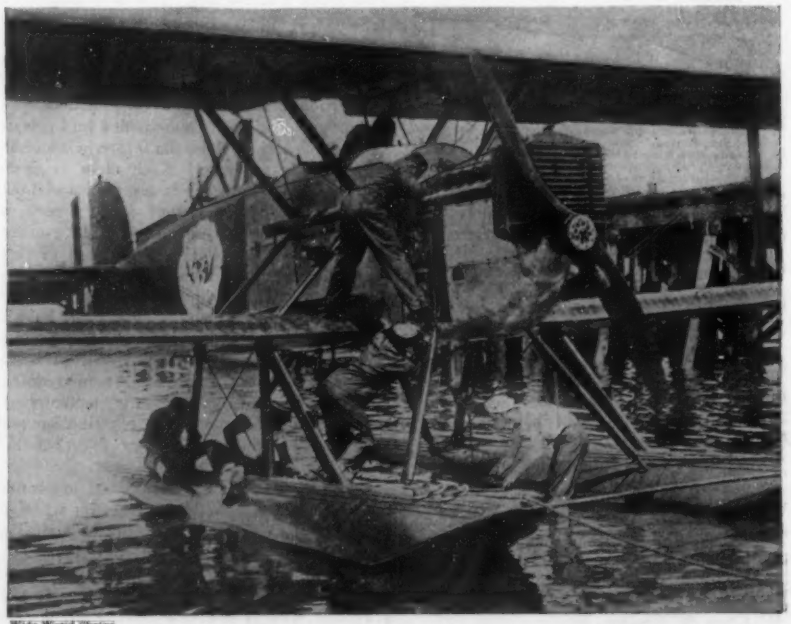
The gallant Commodore was sent to command the British Air Forces in the Mediterranean Sea and had a splendid opportunity to get at these principles. The Mediterranean is supposed to be always like a mill-pond, but as a matter of fact, it was able to provide the flying boat squadrons with every kind of bad weather imaginable.

The hull of a flying boat should be just as seaworthy, just as free from leakage as a large motor boat. A good yacht builder, given a free hand, might perhaps be the most suitable man to achieve this condition.

These large flying boats carry hundreds of gallons of gas. Refueling becomes an important problem. It is impossible to handle the 50-gallon drums in which the gasoline is brought on board, and it has to be poured into four-gallon tins and then into the tanks. The funnel must be protected by a wind shield to avoid waste when refueling in a wind. Sometimes these giant boats cannot make a get-away when heavily loaded. The Commodore insists that provision must be made for rapidly throwing gasoline overboard.

Metal hulls are displacing wooden hulls, and do not leak nearly as much. But either type *will* take on water. The British seamen tried a semi-rotary pump with leads to various compartments of the hull. The leads got choked up and the pumps blocked. Finally a large garden syringe was resorted to. Perhaps the provision of a suitable mechanical pump is not beyond human ingenuity.

A large steamship is mechanized throughout. There is scarcely any heavy hand work left for the crew to do. The same process will apparently follow in seaplanes, although weight limitations impede a similar process of mechanization. Commodore Samson recommends the use of an auxiliary engine to do the electric lighting, supply energy for pumping, current for cooking, for handling



Wide World Photos

Boston 11 to be taken on world flight by Lieutenant Leigh Wade

the anchor and even for slow "taxying" in the water when the main engines are too powerful for careful handling.

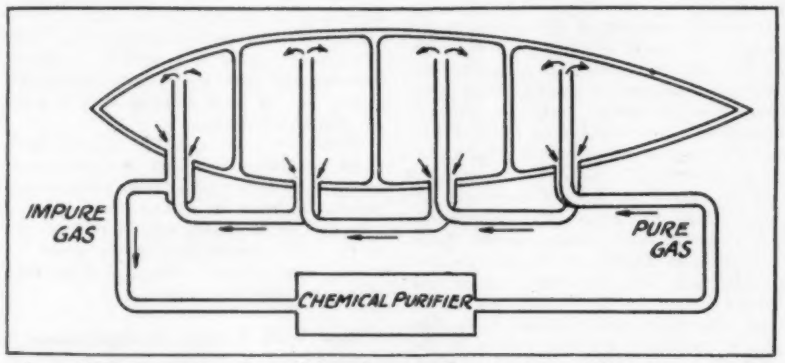
The poet has told us that man cannot do without dinner. The adage is particularly true on board a seaplane. There must be available an electric cooker, and it must be capable of drying clothes. This may seem a great elaboration, but only those who have had to sleep in a boat after and before an eight-hour flight know what a boon it would be.

Mooring a boat appears to be quite a problem. In the extreme bow of the boat there must be room and solid foothold for picking up buoys, using a slip rope and so on. No automobile is nowadays complete without a bumper. The British airmen finally decided that they had to use a fender and saved many a stove-in plank thereby.

The Commodore asks how the boat will ever get-off with all this "junk" which is so vitally necessary. His answer is that the "junk" will have to be carefully and specially designed so as to be light and compact. And he proceeds to describe more junk. Thus, he rigged up two sleeping bunks hinged against the sides of the boat when not in use, with sleeping bags of airplane cloth, and installed photographs and an electric fan on the walls of the hull as well as a multiplicity of cupboards.

In the discussion of hull design, some very interesting observations are found. There should be a good passageway all along the hull, almost to the tail. Cockpits should have water-tight covers. The gasoline tanks should be placed at the sides of the hull or under the deck. There must be an adjustable step for get-away with various disposition of load—a very tricky problem for the designer or inventor. Engines should be mounted so that they can be removed by the crew without dismounting the planes, and should be accessible to the engineer in flight. It is suggested that the engine be actually placed in the hull with propellers driven by shafts and gearing. All the members of the crew should be able to look out through apertures in the hull.

Nothing so valuable for seaplane builders and users has found its way into print for a long period.



A continuous process of purifying the gas of an airship without the necessity for deflation

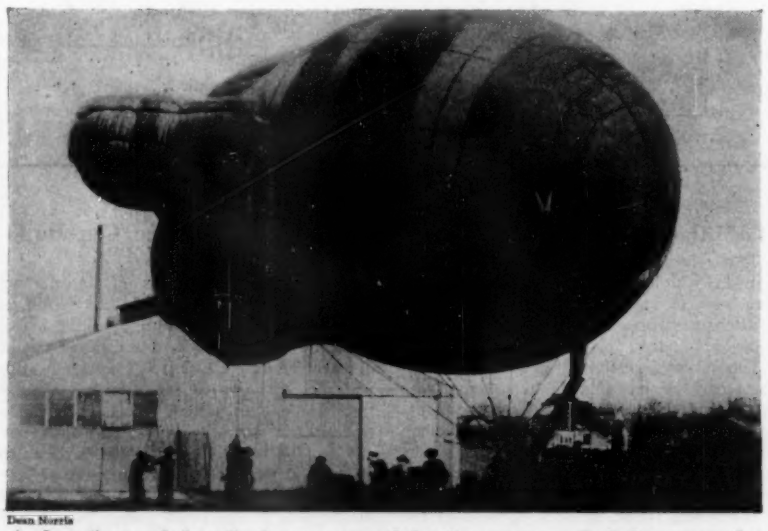
Gas Purging

EVEN goldbeater's skin allows a certain amount of air to leak into the bag of a dirigible and a certain amount of hydrogen to leak out. In time the gas, whether hydrogen or helium loses so much of its purity and lifting capacity that purification or "purging" becomes necessary.

It is customary in purging to deflate the gas bag either partially or completely, and then to inflate with either new or purified gas.

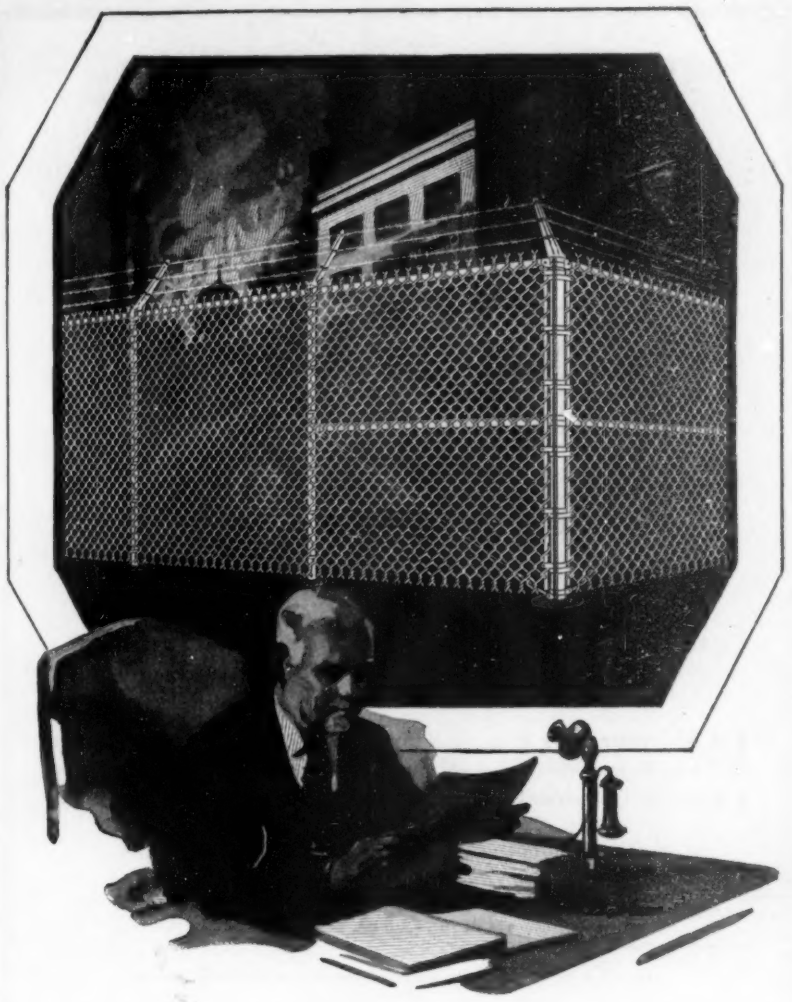
Deflation is long and costly, the flabby bags wrinkle and tear. After three such operations the gas bag is very often out of commission.

In the French *Le Genie Civil*, a very simple suggestion seems to obviate these difficulties. Instead of deflating the gas bags of a rigid airship, they are connected up in series (as shown in the diagram), with each other and with a chemical or electrolytic purifier. There is secured thereby a continuous circulation of impure gases to the purifier and of the purified gases to the gas bags, without the slightest necessity for deflation. This very simple idea has real practical value.



Dean Morris

A close "up and down" of our newest defensive weapon. It is known as the Barrage Balloon. It is shown anchored just outside its hangar at Wilbur Wright field, near Dayton, Ohio. Mechanics are in the act of inflating it for a trip of 20,000 feet in the air to test a set of instruments showing the speed of the wind, temperature, density of air and other climatic conditions in the rarefied atmosphere high above the earth. As a war weapon it is designed to ascend to a great height, trailing fine steel wires extending to the ground and wrecking any hostile airplane in times of war. It is figured a fleet of such balloons would prevent an aerial attack on great cities like New York. The fins on the sides take care of contraction and expansion of gas as the dirigible ascends or descends



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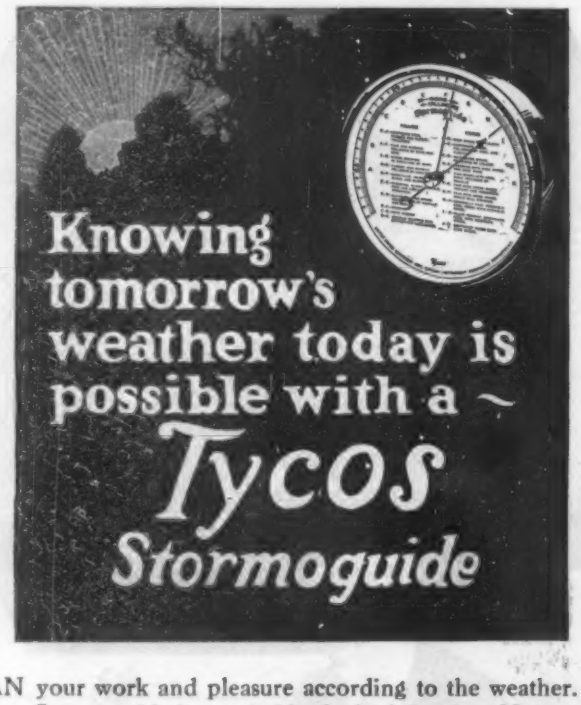

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Radio Notes

A Review and Commentary on the Progress in This Branch of Rapid Communication

Conducted by Orrin E. Dunlap, Jr.

Reactivating Damaged Tubes

CERTAIN types of radio vacuum tubes possess tungsten filaments the metal of which contains small amounts of other elements, usually thorium, the effect of which is to increase the emission of electrons from the filament. If a tube is subjected to too high an "A" battery current this activating material is sometimes driven off almost altogether from the filament surface, so that the electron emission of the tube falls off and the tube becomes almost worthless for actual use in a receiver.

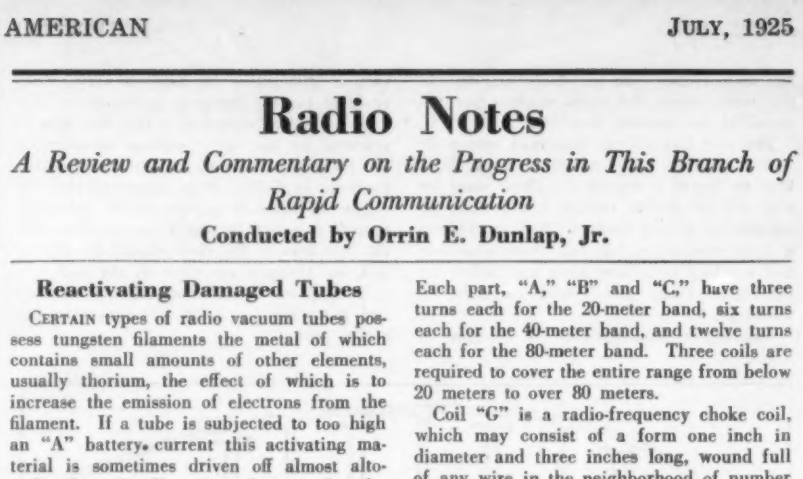
In the case of two types of tubes—UV-199 and UV-201a—this trouble may be removed, says a recent announcement of the Radio Corporation of America, by heating the filament for some time at a definite voltage and without any "B" battery connected to the plate. What happens, apparently, is that some of the active material present in the interior substance of the filament wire migrates out to the surface of the filament, thus restoring the active coating which had been destroyed by the previous misuse.

For UV-199 tubes the voltage used on the filament for this reactivating treatment should be exactly 3.6 volts. This must be measured, of course, by an accurate voltmeter. For UV-201a tubes the proper voltage is exactly 5.5 volts. Two hours' heating at exactly these voltages will usually restore the tube. If this two-hour treatment is not successful, as determined by actual test of the tubes in a receiver, further treatments of five hours and of fifteen hours respectively may be tried. If the final treatment of fifteen hours leaves a tube still unsatisfactory it may be regarded as hopeless.

New Call Letter Designations

THOSE who have low-wave receivers will be interested to know that while the radio call letters of amateurs in all countries of the world are of the same general form, a conventional method has been adopted by amateur operators for distinguishing between the call letters of different countries. The designation consists of the insertion of a single letter made in the interval between the repetitions of the call.

As reported by the American Amateur Organization the letters are: "A" for Australia; "C," Canada; "F," France; "G," Great Britain; "I," Italy; "M," Mexico; "N," Netherlands; and "O," South Africa; "P," for Portugal; "Q," Cuba; "R," Argentina; "S," Spain; "Z," New Zealand; and "U," United States.



The MacMillan short-wave receiver described below

MacMillan's Short-wave Receiver

THIS short-wave receiver has been designed by John L. Reinartz for amateurs who wish to build a low-wave set to pick up messages from the MacMillan arctic expedition.

The circuit is extremely flexible, thus the parts may be mounted in almost any way the individual builder desires for the panel layout. It is necessary, however, to keep very short leads in the grid and plate circuits, in order to reach as low a wavelength as possible.

The tuning inductances, designated by the coil "ABC" and coil "D," may be wound on a form about 3½ inches in diameter, in either spiderweb fashion or as a single-layer winding on a cardboard tube. Coil "D" is the antenna coupling coil and should consist of five turns of about number 16 double cotton-covered wire for the 20 and 40-meter bands, and ten turns for the 80-meter band. Coil "ABC" is really a single coil tapped in two places, as shown in the diagram. Each part, "A," "B" and "C," have three turns each for the 20-meter band, six turns each for the 40-meter band, and twelve turns each for the 80-meter band. Three coils are required to cover the entire range from below 20 meters to over 80 meters.

Coil "G" is a radio-frequency choke coil, which may consist of a form one inch in diameter and three inches long, wound full of any wire in the neighborhood of number 30 double cotton-covered.

Condensers "E" and "F" should have about five plates each, and may, if desired, be cut down to five plates from a larger condenser. Either a dry cell or storage battery tube may be employed, with 45 volts on the plate. The antenna may be the usual receiving antenna or a single vertical wire about thirty-five feet high.

Most Interference Can Be Eliminated

CHARACTERISTIC troubles of interference were recently outlined by A. M. Wilson, of the University of Cincinnati, speaking before the Ohio Electric Light Association, at Cincinnati, Ohio. Defective electric heating pads, used by invalids; sparking commutators on motors of coffee grinders; defective electric stoves; grounded fire-alarm circuits and grounded transformers were cited as general causes for interference.

Railroad crossing bells were found to be the culprits in one small town. Mr. Wilson said that tests definitely determined that mercury arc rectifiers are not sources of radio interference, except during their brief starting period. Voltage regulators are seldom a cause of interference, and under normal conditions magnetite arcs do not annoy listeners. The carrier effect of propagating radio disturbances can generally be stopped by inserting an inductance in the leads of the cause of the interference and by con-

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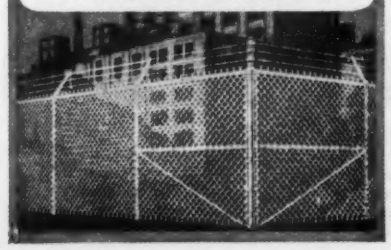

necting condensers across the line between the inductance and the source.

A sensitive set is necessary to trace the disturbance and locate the source. Excellent results have been obtained by the use of a loop antenna connected to a thoroughly shielded receiver. The shielding gives maximum benefit of the directional property of the loop. The noise will be loudest when the loop is pointing toward the source and, by following it up, the disturbance can be tracked.

Power companies are generally willing to cooperate with broadcast listeners to minimize interference. Listeners in Pelham, New York, were troubled for over a year with interference which they attributed to power lines of the Westchester Railroad. Engineers of the company made a test to locate the trouble. At three o'clock one morning fifteen electrical circuits operated by the railroad were disconnected one at a time in order to single out a noisy one. The process of elimination continued until finally the noise stopped, when one circuit was shut off at the central office, in accordance with a telephone request made by the engineers in charge of the observation. A superheterodyne in conjunction with a loop was then used along the line to find the definite spot where the interference started.

Radio fans in the vicinity of Johnstown, Pennsylvania, were troubled with interference, which they blamed on nearby industrial plants, the Bethlehem Steel Company, Penn Public Service Corporation, and the Pennsylvania Railroad. The executives showed a spirit of cooperation with the government radio supervisor and the Bethlehem steel plant shut down for intervals after midnight on Sunday mornings. The high-power electric bus power line was shut off and the feeders energized one at a time to locate the cause of the trouble.

A recent case of interference at Madison, Maine, was traced to a beauty parlor. An electric vibrator set up Hertzian waves of its own which radio sets in the neighborhood picked up.

The designers of the short-wave radio transmitting and receiving apparatus which will be used on the MacMillan Arctic Expedition. The two-meter transmitter employs the Reinartz-Zenith circuit described on the preceding page. Left to right, H. C. Forbes, Lieutenant John Reinartz, Dr. Karl E. Hassel

KGO Radio Actors Perform Within a Circle of Light

WHEN radio dramas are broadcast from station KGO, Oakland, California, the actors perform within a circle of light about ten feet in diameter. The microphone is suspended on top of a pedestal in the center.

The impresario of the California station found that radio players have the feeling of being alone with the microphone when they are grouped or seated within a circle, bound in by darkness. In a brightly lighted studio the actors are conscious of each other and incidently aware of the microphone. In the lighted circle they are conscious only of the microphone and their acting is said to be improved, and much more effective at the receiving end.

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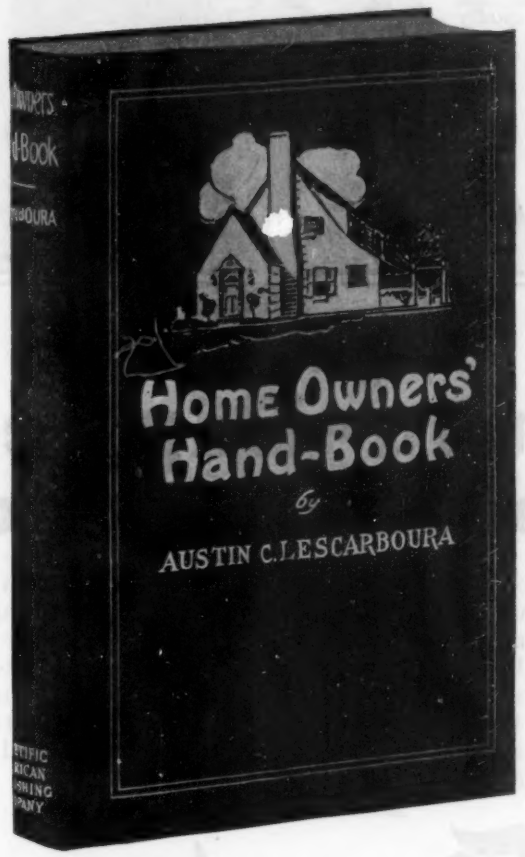

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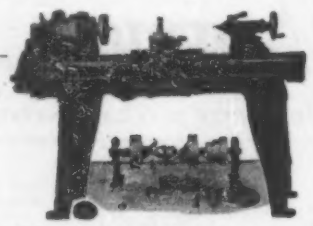

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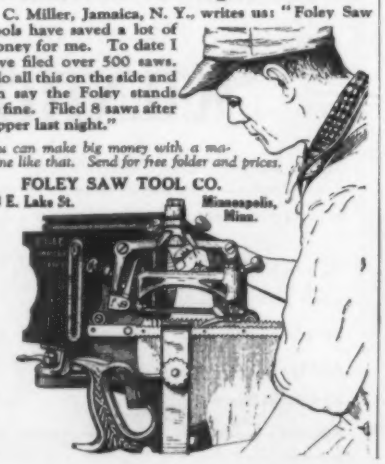

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Radio Guidance Speeds Up Shipping on the Lakes

NEW radio compass and beacon stations along the Great Lakes are expected to speed up the lake traffic this summer. Heretofore, heavy fogs, especially over Whitefish Bay and the St. Mary's River, have held up shipping for as long as twelve hours, before the fog lifted to allow ships to proceed toward the locks at the Soo.

The lighthouse tender *Amaranth* at Detroit, Michigan, has been equipped with the Kolster radio compass. This is the first lighthouse vessel on the Great Lakes to be fitted with the new aid to navigation. Used in conjunction with the radio beacon stations at the Detroit River Light, Buffalo Light, Lake Huron Lightship, Detour Light, White Fish Point Light, Manitou Light, and Devil's Island, the radio compass provides an excellent means of position finding.

Radio beacon stations are planned for four more points on the lakes—Chicago Harbor Light, Milwaukee Light, Lansing Shoal Lightship and Superior Entry Light.

New Appliance Solves Antenna Lead-in Problem

ONE problem every radio fan meets is the entry of the lead-in to the set without drilling a hole through the window frame or side of the house. This troublesome task has been overcome by what is known as a "lead-in strap."

The strap consists of a strip of heavily tinned copper which has a Fahnestock clip soldered to each end. Heavy insulation is wrapped around the center of the strap and under this is placed a strip of stout webbing. The strap is placed on the window sill, and when the window is closed the sill rests on the insulated part.

It is often difficult to solder connections in an antenna system and unless the joints are soldered or are well made they soon corrode when exposed to the weather. The lead-in wire may be fastened directly to the Fahnestock clip, and the wire to the set fastened on the clip at the other end.

It is generally a good idea to place the lead-in at the top of the window, where it will be out of the way and where there will be no danger of disturbing it by opening the window. It is better protected from the window in this manner, and the lead-in does not show in front of the window. This strap has gained the favor of landlords because its use does not in any way spoil the appearance of the woodwork.

International Show

AN International Wireless Exhibition will be held at Geneva, Switzerland, from September 23 to October 4.

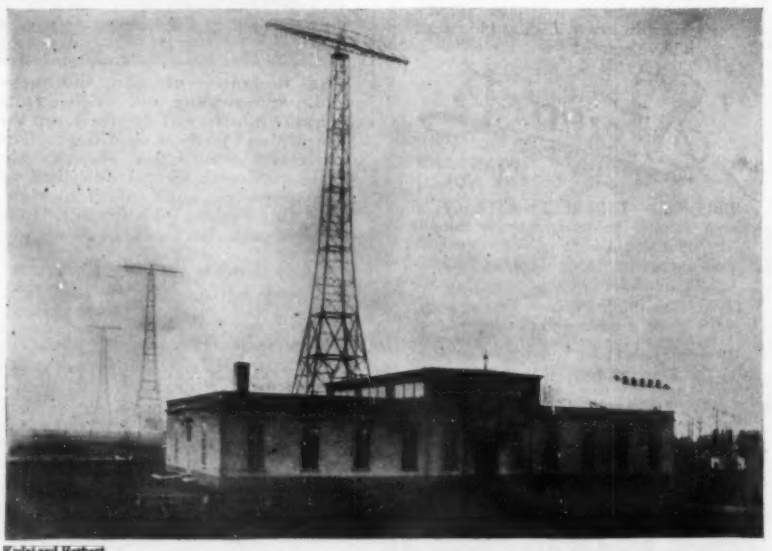
New Vacuum Tube Works on Alternating Current

RADIO research engineers seem to be waging a laboratory war against both "A" and "B" batteries. Many believe that the next logical step in radio will be the tube which will operate in connection with alternating current. Such a tube, invented by F. S. McCullough, of Wilkingsburg, Pennsylvania, formerly an engineer with the Westinghouse Electric and Manufacturing Company, was placed on the market last month. It dispenses with the "A" battery but not with the "B" battery. This tube does not burn brilliantly but glows with the intensity of a lighted cigarette, yet engineers say that this subdued glow casts a light on the future of radio, when receivers will be operated like electric irons and vacuum cleaners, attached to the light sockets.

The McCullough tube operates on four volts, 60-cycle alternating current and each tube draws one ampere. The tubes will work on direct current providing the elements in the tube, known as the heaters, are wired in series, instead of parallel as is the case when alternating current is used. No high-voltage alternating current flows through the wires of the radio set. A small 75-watt step-down transformer, ranging from four to six volts, and resembling the toy transformer used by boys to run electric trains and motors, is used external of the set, and thus, the 110 volts does not pass into the set.

The tube has an electrical heater, mounted within a porcelain rod, used to conduct the heat to a cylindrical cathode, surrounding the rod and heater. The porcelain rod insulates the heater electrically from the cathode. The cathode is surfaced with an oxide coating, which when heated to a low temperature gives off electrons, similar to the ordinary vacuum-tube filament. The cathode and heater in combination take the place of the filament. The heater furnishes the heat through the porcelain insulation of the cathode, which actually emits the electrons.

The tubes are a trifle larger than the ordinary vacuum tube, yet they are designed to fit the standard vacuum-tube sockets. No rheostats are required. The A-400 tubes are uniform in their performance as audio-frequency amplifiers and detectors. The R-400 is a radio-frequency amplifier. The wires which carry the alternating current to the tubes run along the top of the glass bulbs. A five-tube set requires about 120 volts "B" battery and a 4½-volt "C" battery. The wiring is similar to the average receiver except for the filament circuit. A five-tube set has three dials, one to tune the antenna; the second to tune the coupling between the first and second stage of radio-frequency amplification and the third dial tunes the



Kadel and Herbert

Sweden is equipped to participate in any world-wide radio activities. The above photograph shows a high power station at Grimeton, near Gothenburg, on the west coast of Sweden, the most powerful broadcasting station in that country. It is in daily communication with the United States, and plans are now under consideration to use it for the daily transmission of press despatches. Its 400-foot towers extend on a line for a mile and a half

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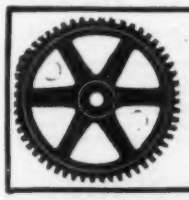

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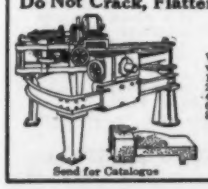

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coupling between the second radio-frequency amplifier and detector.

The great difficulty engineers have encountered in designing a tube of this character has been to eliminate the hum caused by alternating current. It is apparent that the McCullough tube has overcome this trouble, as there is no perceptible hum even when a cone-type loudspeaker, which is noted for its reproduction of the low tones, is used.

The appearance of the alternating-current tube does not mean that present sets operating with batteries will be obsolete within a year or even five years. This is a new tube and it is destined to have many improvements and refinements before it can replace the practical battery tube. Furthermore, there are millions of homes not wired for electricity, thus the batteries will long be popular.

It is estimated that approximately 3,000,000 homes in the United States are equipped with radio receivers, and that 1,000,000 of these homes are wired for electric lights. It is calculated that about 2,000,000 radio fans use storage batteries, 900,000 dry batteries, and 100,000 crystal detectors, which do not require batteries. One battery manufacturer estimates that within the next five years the number of radio sets in use will be increased to 10,000,000. Approximately 1,000,000 homes are wired for electricity each year, and in five years half the homes having radio sets will have electric current for lighting.

A five-tube neutrodyne installation in the car of J. D. R. Freed. Alongside the rear seat is a plug for the phones. The tubes are lighted with a filament switch operated by the insertion of a plug on the key ring. The power is furnished by the battery carried for ignition purposes on the car, so that the battery is always charged. The antenna consists of sixty foot of wire concealed underneath the roof of the car and covered by cloth or plush

Secrecy Guards Tests Between America and England

SUCCESS of experiments in transoceanic radiotelephony have led to the prediction by engineers that commercial transatlantic radiophone conversations will be a regular part of the telephone system before many years pass. It will then be possible to lift the receiver of the ordinary house telephone in any section of the United States and ask central for a number in London, just like a long-distance call is made.

It is understood that the experiments have utilized an entirely new principle of wireless and it is being guarded with secrecy. A special form of carrier wave is radiated from the big station at Rocky Point, Long Island, which serves the same purpose as a telephone wire, along which the voice can be sent in both directions. The voice currents are superimposed on the carrier wave. The words are picked up at Chedzoy, England, and are then passed through transformers and forwarded to London by underground wires.

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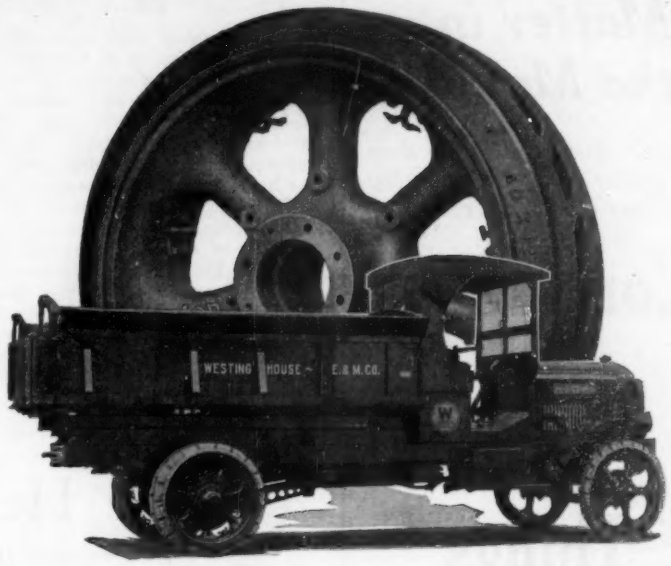

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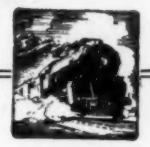

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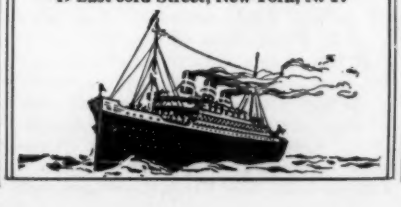

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Airplane's Radio Exhibits Peculiar "Jump Over" Effect

A NAVY airplane flying in the vicinity of the Naval Air Station at Anacostia, D. C., was heard 2,000 miles when it broadcast messages from a short-wave transmitter. St. Paul, Minneapolis, and Tampa, Florida, tuned in the aircraft's signals, but stations much nearer could not detect the waves. The Naval Research Laboratory at Bellevue, D. C., was in communication with the plane on the 20-meter wave up to a distance of 60 miles, at which point the signals disappeared. The Navy's experiments with this type of short-wave apparatus have shown that signals on wavelengths below 40 meters have what is termed a "jump over" effect; that is, they vanish after a moderate distance is traveled and then reappear when the plane reaches a more distant point.

While the plane was in flight reception on the 20-meter wave was possible only up to 40 miles, because of excess interference produced by the ignition system of the engine. There are 24 spark plugs in the Liberty engine and each one acts as a miniature transmitting station, radiating energy on about the 20-meter wavelength. Like all spark signals such waves are broad and cannot be easily tuned out. The Naval Research Laboratory is developing a short-wave equipment of extremely light weight for aircraft.

Road Reports Broadcast

THROUGHOUT the summer, the State Highway Department and Boston Motor Club will broadcast Connecticut highway conditions and detours every Friday at 7:45 P.M., through station WNAC. The information will be for the benefit of commercial trucking interests and pleasure vehicle drivers.

The Heavens in July

By Professor Henry Norris Russell, Ph.D.

At 11 o'clock: July 7.
At 10½ o'clock: July 14.
At 10 o'clock: July 22.
At 9½ o'clock: July 30.
At 9 o'clock: Aug. 7.
At 8½ o'clock: Aug. 14.
At 8 o'clock: Aug. 22.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on July 7, etc.

NIGHT SKY: JULY AND AUGUST

The Heavens

THE summer stars now show in their full glory. Vega is almost overhead, Deneb very high in the northeast, and Altair high in the southeast, Antares about S.S.W. and Jupiter (which is brighter than any of the stars) in the S.S.E., Arcturus, due west, and Spica, low in the west, complete the list of the brightest stars in sight. Corona and Hercules are between Arcturus and Vega, Ophiuchus and Serpens between these last and Antares. Pegasus is low in the east, and the two Bears, the Dragon and Cassiopeia are in the northern sky.

The Planets

Mercury is an evening star this month, and is best visible toward its close, when he is 27 degrees from the sun, and sets at 8:20 P.M. Venus is also an evening star, and so is Mars. A remarkable conjunction of the three planets occurs on the 11th, when all three are within a circle three quarters of the apparent size of the moon. Venus is the northernmost, then Mars, a quarter of a degree away, then Mercury, only one tenth of a degree further south, so that the two planets should be just comfortably separable to the naked eye.

This very close approach occurs while it is daylight in America, and by the time we can see them they will have strung out a bit, Mercury being the farthest east; but they will all be visible very close together in the twilight and well worth watching.

Jupiter is in Sagittarius and comes to opposition on the 10th, so that he is visible all night long. Saturn is in Virgo and comes to the meridian shortly after dark. Uranus is in Pisces, and souths about 4:00 A.M., and Neptune in Leo, too near the sun to be well seen.

The moon is full at 11:54 P.M. on the 5th, in her last quarter at 4:34 P.M. on the 13th, new at 4:40 P.M. on the 20th, and in her first quarter at 3:23 P.M. on the 28th. She is nearest the earth on the 6th, and farthest away on the 20th. She is in conjunction with Jupiter on the 6th, Uranus on the 10th, Mars on the 22d, Neptune, Venus and Mercury on the 23d, and with Saturn on the 28th.

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Science and Money

Street Railway Securities

Motor Busses Slowly Affecting Street Railway Operations

By Chase Donaldson

MOTOR busses have won for themselves a permanent place in the transportation field. Street railway securities, therefore, will be definitely affected—whether for better or for worse remains to be seen. Prior to a year or so ago, many enthusiasts went so far as to say that the electric railway was doomed, and that swift, comfortable, rubber-tired busses would take its place. Now, a more moderate opinion prevails, and certain lines are drawn between the uses of the street car and of the bus. The street railway operators, the bus manufacturers, and many of the municipal authorities are gradually reaching agreement on certain fundamental principles of transportation. Such a state of accord should in time have a favorable effect upon the securities of many street railway companies.

Certain transportation principles have resulted from the disastrous experiences of the last few years. Beginning about 1914 a plague of jitneys descended on the country and threatened to disrupt completely the established transportation facilities. After the jitney, the small independent bus continued the competition with the street car. Now larger capacity busses are operating in fleets, some owned by the electric railway companies, and others by the still competing bus companies. In many States, bus operation has been brought under the jurisdiction of the State public utilities commission. The application of the principle of regulation to motor busses has produced two results: First, unfair competition is prevented, and, second, the public is assured of proper service at fair rates from busses and trolleys alike.

Naturally the street railway people were disconcerted when the bus first threatened to drop a wrench in the wheels. The more far-sighted operators, however, slowly recognized in the bus an ally of no mean importance, and preserved their existing leadership in transportation by promptly applying the bus to its proper uses. For the most part, they have used the bus as a feeder to their rail lines.

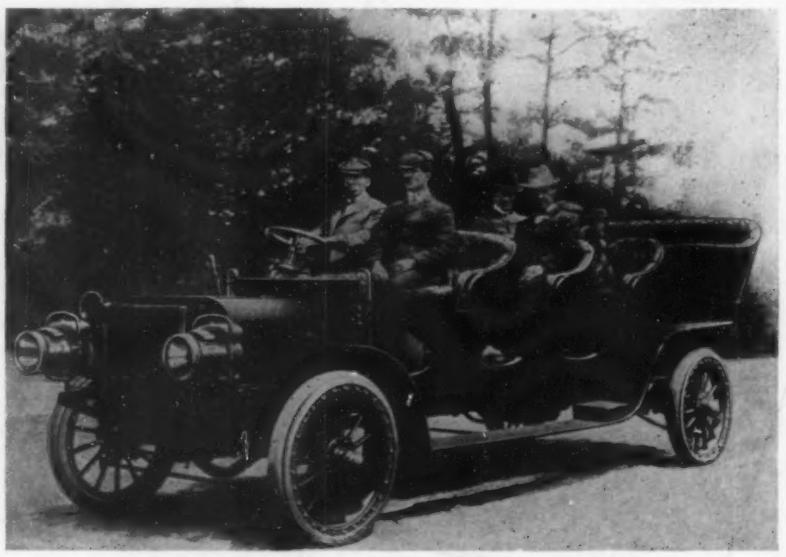
Many suburbs have been built up in the last few years, and the railways have not been able to afford the cost of the necessary extensions, nor could they have obtained the money to finance them. A bus line into these unserved districts stimulates traffic and helps to improve relations with the riding public.

This use of busses as feeders and as supplementary lines has been most apparent in the larger cities. In many smaller towns throughout the country, the equipment had become so dilapidated and so expensive to maintain on the small volume of traffic that the companies either gave up the ghost entirely or substituted busses. Not including the large number of companies that had been driven out of business by competitive bus operations, about fourteen railway companies have abandoned all of their railway service and installed busses.

Growing interest is being shown by the street railway companies in the use of busses. The doctors do not agree on how well the infant industry is progressing: the bus people stated that, as of the first of the year, 204 electric railways were operating 2,915 busses on 616 routes; the railway people figured that there were 171 companies operating 2,600 busses. Measured by the railway figures, the increase over 1923 is most significant. In a fifteen months' period the number of busses used by the electric railways increased 229 percent. The number of railways using busses increased 70 percent and the miles of route increased 270 percent. Evidently, many of the companies saw fit to expand their bus operations during this period. Furthermore, it was announced in the January issue of the American Electric Railway Association Journal that twenty-four additional companies were contemplating the use of busses.

The operators of the electrical railways were not particularly quick to appreciate the advantages of the bus for their purposes. In their trade journals of but two

(*Continued on page 70*)



The first motor bus in America, in the year 1900

Regulation by State commissions is in itself a recognition of the permanent place of the motor bus in the scheme of transportation. That place appears to be as an auxiliary of the street car in the larger cities where great masses of the people must be carried, and as a supplanter of the street car where the traffic density is insufficient to support the investment in electric facilities.

Certain other functions are better performed by the bus than by the trolley car. De Luxe service at a higher price on boulevards where the sight-seeing element is important, interurban travel of a more comfortable character, or by a more direct route than is furnished by the electric lines, and chartered service for outings—all give the bus a field of activity not necessarily in direct competition with the electric railways.

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years ago a rather bitter tone towards the bus is sometimes apparent. The change in their attitude has been most decided, and now their journals are full of discussions on bus operating problems. A bus manufacturer in a talk at a recent convention of railway operators took a sly dig at their earlier attitude. He smilingly referred to the precautions he had taken at the convention two years previous when he had filled his pockets with nice, hard red apples for ammunition in case of attack from the opposition. Public opinion has been particularly insistent in demanding bus service, and the operators have been forced to protect themselves.

Many of the bus manufacturers, too, were not particularly discerning in their first attempts to supply the demand for busses. Existing truck chassis merely had flimsy bodies perched on them, and little change was made in the essential features of design. Now, the chassis and mechanical parts are designed for the maximum of reliability in service, and for the minimum of maintenance costs. The important parts of many busses are now built in units to prevent delays in maintenance. A complete engine, for example, is substituted for the one that needs repairs, and the bus goes out on its route again. The bodies are now much more comfortable and convenient and their appearance has been measurably improved. The electrical people still believe, however, that further improvements can be made in such details as braking, less jerky starting through the use of a better kind of transmission, and satisfactory interior lighting.

A degree of uniformity is now being reached not only in design, but also in operating methods. One of the first attempts to point out the principles of sound bus operating methods has been made in a recent book by Hauer and Scragg called *Bus Operating Practice*. This work covers such subjects as routes, state regulation, selling the service, operations, costs, and so on.

From our brief review of the regulation and uses of the bus, the attitude of the street railway people, and the improvements in bus design and operation, it is evident that the bus has a definite place in the transportation field. The electric railway, however, also has its own special function as an economical means of carrying large masses of people in congested districts. The bus, according to the street railway people, has not yet proved its ability to handle peak loads as well as they can be moved by the electric car on rails.

This conclusion brings us to the effect of the motor bus upon street railway securities. The year 1923 marked the largest number of passengers carried by the electric railways in their history—over 16,000,000,000 persons. The year 1924, which was one of lesser industrial activity, showed but a decrease of two percent from this total. These facts indicate that, in spite of the tremendous increase in the number of motor vehicles of all kinds, the electric railway industry as a whole is not losing ground.

Individual companies and their securities cannot be considered in the same light as the industry as a whole. A few warnings must be heeded. The larger companies operating in centers of heavy traffic are in a position of greater security than those companies which operate in small, sparsely settled communities. This assumption is true only, of course, if the companies are given fair treatment by the municipal and state authorities in the matter of fares. In general, too, the bonds of the underlying companies operating where traffic is dense are in a more secure position than are the notes or debentures of a holding company. Another question to watch is the attitude of the city officials and politicians. Continual agitation for municipal ownership and reduced fares is most harmful to street railway credit.

Furthermore, a company that is not protected from unfair motorbus and jitney competition by the rulings of an unbiased state commission is in a precarious condition. And if a company is still opposed to the use of busses, the investor had best transfer his allegiance to a more far-sighted management.

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AN APPEAL

THIS appeal on humanitarian grounds from Leonard Wood, Governor-General of the Philippine Islands, should go straight to the hearts of the American people. He is known to us all by his great administrative work a quarter of a century ago in Cuba, and his equally fine work today in the Philippines. We most earnestly commend this appeal to our readers.

Office of the Governor-General of the Philippine Islands
Manila, April 20, 1925.

DEAR MR. MUNN:

In the past I have found that the writers of America, whenever there exists an urgent need, give their earnest and sympathetic support.

In the Philippine Islands we appear to be on the verge of discovery of methods which may eventually free the world of that age-long and world-wide scourge—leprosy.

The Insular Government is appropriating every cent possible to care for and treat the twelve thousand lepers in the Islands. In spite of this we need additional funds to accomplish our desired end—the absolute cure and ultimate control of leprosy. We need $1,000,000 and I am making an appeal to America to give it.

We were successful in our efforts to eradicate yellow fever and to control malaria in Cuba. The methods there employed have made the Tropics as safe as the Temperate Zone. We have rendered the Philippine Islands safe against cholera, smallpox and plague by scientific methods of control.

We are now carrying on this great campaign for the control and eradication of leprosy. The American people have ever been generous in supporting movements of this kind, and I again appeal to their generosity and spirit of service in behalf of these stricken people, who are the most unfortunate and afflicted of God's creatures.

Contributions may be made payable to the Chief of the Bureau of Insular Affairs, War Department, Washington, D. C. They will be transmitted to the Philippine Islands and spent under the direction of the Governor-General.

Very sincerely,
(Signed) LEONARD WOOD.

BRYAN

FOR each person who knew something about Evolution three months ago there are ten today. The quickest way to propagate a reform of any kind is to find some way to get people to argue about it. Whether the majority favors it or not matters less at first than the fact that they have come to recognize its presence and some of its implications. "I don't care what they say about me," said P. T. Barnum, that pioneer American publicity expert, "so long as they talk about me."

Mr. Bryan is evolution's publicity man. Evolution—understood more or less inaccurately, but understood—had been slowly seeping into some minds for many years. This year it has seeped a great deal faster.

Thanks, Mr. Bryan.

In This Issue

Is the Material Universe Only a Transient?
It begins to look as though the whole material universe were nothing but a temporary form of energy. Suns radiate matter away in stupendous volume and there is some evidence that this radiation is recreated in the form of new matter in distant parts of space. On page 80, Sir Oliver Lodge explains how this may happen and what it means. Sir Oliver has the knack of making things lucid.

"Stop, Look and Listen"
The old sign was all right when Uncle Zeke drove the one-hoss shay, but we need something better to keep the automobilist of today from the consequences of what we see him doing on the cover of this issue. H. W. Slauson tells what in the leading article.

Furs That Look Like What They're Not
This month the fair sex will be shopping for their winter furs. Wives, and husbands, too, may profit if they first read Milton Wright's article on page 82; otherwise what they get may be quite different from what they ask for.

Airplanes That Need Never Come Down
The problem of refueling a plane in the air under any and all circumstances has been solved. Major H. H. Arnold, of the United States Air Service, tells how it is done.

A New Kind of Cow Made to Order
Have you ever heard of a cattalo? It is the grandchild of a domestic cow and a buffalo, and like a combined Munsey newspaper it "retains the best features of each." On page 89 we tell how they are breeding them in the Canadian Northwest.

MORE THAN ONE HUNDRED PICTURES

Complete table of contents will be found on page 144.

For Next Month

A Panic in New York
It is not impossible that some disaster would set a million people from our skyscrapers milling madly in the streets. In an article by Mr. James H. Collins—part of which is an interview with Fire Chief John Kenlon—he tells what might happen and where the safest place would be.

Maybe Our Universe Is Not Infinite
Two astronomic paradoxes cast a doubt on infinity: one that the star-sprinkled night is not bright like noonday; the other that the attraction of gravitation on the earth is not equal in all directions. Professor Nicholas Rashevsky tells how a finite "star-cloud" universe might explain these things.

If You Could See a Bullet Fly
Bullets don't act as they ought to act. They cut capers in flight that have kept scientists guessing for decades—first, as to exactly what they do; and second, why. Now the United States Army ballisticians and civilian scientists are making pictures of bullets on the wing, in one-3,000,000ths of a second. What they find is a revelation. In the September issue.

Other articles on Lights That Cast No Shadows, on Grisly Trophies of the Jivaros, on Diluted Darwinism, on The Work of Our Aviation School of Medicine.

MORE THAN ONE HUNDRED PICTURES

¶ ***The last few issues of the Scientific American have been sold out. Don't miss the next one. You will need it on vacation.***

We will mail three issues to your vacation address for only one dollar.

GLASS HOUSES

EXCERPT from a recent issue of *The Dearborn Independent:*

"It is not often that the Scientific American lets itself in for criticism so obviously as in its study of Muscle Shoals, in the May number. No propagandist of the power trust has ever quite so baldly ignored the whole reason for Muscle Shoals' existence, nor so ruthlessly thrust aside the possibilities of its present usefulness. . . ."

People who live in glass houses should not throw stones—yet Henry Ford, through his *The Dearborn Independent,* is doing that very thing. He accuses us of playing into the hands of the interests or power monopoly when in our recent article on Muscle Shoals we suggested that the only practicable use for this plant would be to employ it as a power plant and couple it up with the great superpower scheme of supply at cheap rates to the country at large. We had our staff representative investigate Muscle Shoals and he formed his own independent judgment as to the best disposition to be made of it for the interests of the country at large. His conclusions met with our editorial approval; they seemed to be impartial, just, reasonable and conclusive. The article has brought many letters of approval from hydraulic and chemical engineers of national standing.

Mr. Ford is a prospective purchaser. He wants a monopoly. We are not prospective purchasers and in this, as in every investigation, we hold that position of absolute independence which has always been the strongest asset of the Scientific American. We do not live in a glass house; Mr. Ford does. His cherge that we are favoring the power monopolists will make our readers smile.

CONTROVERSY

WELL, the smoke of battle fills the air and the fight is on! Our Mr. Walker delivered the first broadside in the month of May with the declaration that the United States "Treaty Navy" is second to none. This month, Captain Knox, U. S. N. (retired), ranges alongside and delivers a full broadside entitled "Another side of the 5-5-3 ratio." The Captain is the chief proponent of the regular line officers of the Navy, who claim that the British have a preponderance of strength which is not evident on the face of the lists adopted by the Arms Conference. Meanwhile, Walker has lots of reserve ammunition and will reply to the gallant Captain.

PSYCHIC

IS the simple test of "spirit return" described by Dr. J. Allen Gilbert on page 85 a fair one? We think so.

Locked in our safe is a triply sealed envelope containing a countersign agreed upon by Dr. Gilbert and Mrs. Gilbert before Mrs. Gilbert died. A reward of $500 is waiting for the medium who can tell what that countersign is.

It is an opportunity sincere mediums will not fail to grasp as a means of justifying their claims.

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